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XXXI

# The Paleontology and Stratigraphy of the Marine Pliocene and Pleistocene of San Pedro, California

BY RALPH ARNOLD

[Reprinted from the Memoirs of the California Academy of Sciences
Vol. III]

STANFORD UNIVERSITY, CALIFORNIA
1903

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# THE PALEONTOLOGY AND STRATIGRAPHY OF THE MARINE PLIOCENE AND PLEISTOCENE OF SAN PEDRO, CALIFORNIA

---

A DISSERTATION PRESENTED TO THE FACULTY IN GEOLOGY OF THE LELAND STANFORD JUNIOR UNIVERSITY, FOR THE DEGREE OF DOCTOR OF PHILOSOPHY.

## PREFATORY NOTE.

This memoir is the thirty-first of a series designed to illustrate investigations and explorations connected with the Hopkins Seaside Laboratory, an adjunct of the biological laboratories of the Leland Stanford Junior University. These investigations have been carried on by means of the assistance given by Timothy Hopkins, Esq., of Menlo Park, California. This memoir appears in the publications of the California Academy of Sciences, the present edition being a reprint.

OLIVER P. JENKINS,
CHARLES H. GILBERT,
*Directors Hopkins Laboratory.*

Date of publication, June 27, 1903.

# THE PALEONTOLOGY AND STRATIGRAPHY OF THE MARINE PLIOCENE AND PLEISTOCENE OF SAN PEDRO, CALIFORNIA.

BY RALPH ARNOLD.

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# ERRATA.

Page 107, last line, after (Cooper) insert San Pedro; Santa Barbara (Arnold).

Page 112, 17th line, for "*flucicolus*" read *fucicolus*.

Page 142, last line, after *Cytherea* insert *radiata* Sby.

Page 144, 4th line from bottom, after *Carpenter* insert var.

Page 145, 4th line, for "*C. diaphana*" read *C. subdiaphana*.

Page 166, 12th line from bottom, after *Sowerby* insert var.

Page 185, top line of foot-note, for "Dr. W. N. Dall" read Dr. W. H. Dall.

Page 233, 11th line from bottom, for "*M. woodwardi*" read *N. woodwardi*, and for "*gibbsii*" read *gibbesii*.

Page 243, 5th line, for "*tenuispena*" read *tenuispina*.

Page 253, 7th line, for "stuarti *Smith* var." read orpheus var.

Page 307, 17th and 19th lines, for "*Calyptrea*" read *Calyptræa*.

Page 339, 3rd line, for "*Fissuridæ*" read *Fissuridea*.

# INTRODUCTION AND ACKNOWLEDGMENTS.

THE field work upon which this paper is based began in the winter of 1886, when the writer first visited the fossil-bearing beds of San Pedro. Since that time several visits have been made each year to the beds in that vicinity, generally after heavy rains, when landslides and the breaking off of the banks have given new exposures. The specimens obtained during these excursions are in the collection of the writer's father, Delos Arnold of Pasadena, California, and have furnished most of the material on which the present paper is based. It was first intended to compile a list, with synonymy, of the fossils of San Pedro and vicinity, but the scope of the paper has been enlarged until the present work is the result.

One of the obstacles met with in the preparation of this work has been the lack of systematic information in regard to the fauna and stratigraphy of the Pleistocene of the Pacific Coast. Dall, Cooper, Gabb, Ashley and Merriam have published notes on the faunal aspects of the marine Pleistocene of the coast of California; while Whitney, Lawson, Fairbanks and Ashley have contributed to our knowledge of the geology and stratigraphy of the Pleistocene. The inadequacy of these observations has led the writer to visit as many localities as possible in the endeavor to obtain information that would add to the knowledge of the Pliocene and Pleistocene of California. Enough evidence was obtained at the different points along the coast to warrant the statement that we have in the California deposits the greatest development of the marine Pleistocene in the world. Future investigations are necessary in order to give more accurately the thickness of the sediments deposited and the amount of orogenic movement which has taken place since the beginning of the Pleistocene epoch. The future study of the Pleistocene fauna will no doubt add greatly to our knowledge of the relations existing between the Tertiary and living faunas.

Besides the collection of Delos Arnold, the writer has had access to the collections or material belonging to the following institutions or individuals:

1. Leland Stanford Junior University: Geological Department collections.
2. University of California: Geological Department collections, State Geological Survey collections, and State Mining Bureau collections.
3. California Academy of Sciences: Paleontological and Conchological collections.
4. The private collection of Mrs. M. Burton Williamson, Los Angeles, California.
5. The private collection of Mrs. T. S. Oldroyd, Los Angeles, California.
6. The private collection of Mr. Henry Hemphill, San Diego, California.

Dr. James Perrin Smith, Professor of Paleontology in Leland Stanford Junior University, has had general supervision of this paper during its preparation. He has accompanied the writer on journeys that covered much of the territory under discussion, and has offered many valuable suggestions regarding the faunal relations and stratigraphy of the San Pedro formations.

The writer is indebted to Dr. John C. Branner, Professor of Geology in Leland Stanford Junior University, for valuable suggestions in regard to the field work and compilation of this paper.

Dr. William Healey Dall, of the United States National Museum, has identified numerous specimens sent to him, acknowledgment for which is given with each species. Dr. Dall has also prepared the diagnoses of the family Pyramidellidæ, and has furnished drawings of the species of that family, and for the corals; and in many other ways has extended courtesies during the preparation of this work.

Dr. John C. Merriam, of the University of California, has given free access to all of the collections under his charge; has extended many other courtesies; and has offered suggestions which have added to the value of the paper.

The writer is indebted to his father, Delos Arnold, for the use of his collection; for notes and suggestions on the stratigraphy of the San Pedro deposits; for assistance in the preparation of the drawings; and, most of all, for the interest manifested by him in procuring the material upon which much of this paper is based. The field work and collecting has been done as much by him as by the writer. For the past fifteen years he has made numerous visits each year to the San Pedro beds, and to his untiring efforts is due the discovery of such a large number of species in them. He has also visited and made systematic collections from the deposits of Santa Barbara, Ventura, San Diego and other localities along the southern California coast.

Acknowledgment is also due to Mr. T. Wayland Vaughan, Dr. R. E. C. Stearns, Mr. Henry Hemphill, Dr. A. A. Wright, Mr. J. Howard Wilson, and others.

The illustrations are from drawings by Dr. J. C. McConnell, Misses Winnifred M. Paine and Fanny H. Mitchell, Messrs. H. R. Johnson, R. E. Renaud and R. Arnold.

Where the types of new species belonged to Delos Arnold, these types have been deposited in the United States National Museum at Washington, and, where possible, duplicates will be deposited in the paleontological collections of the California Academy of Sciences, and of Leland Stanford Junior University.

# PART I. GENERAL DISCUSSION.

## CHAPTER I.

### TOPOGRAPHY AND GEOLOGY OF SAN PEDRO.

#### 1. TOPOGRAPHY.

THE most prominent topographic feature about San Pedro is San Pedro Hill, an abruptly projecting headland of the coast, rising to a height of 1,482 feet. Along its southern base is a sea cliff varying in height from one hundred to three hundred feet, while to the east the cliff rarely exceeds fifty feet in height. The hill is terraced to within two hundred and forty feet of its summit, and the observations here recorded began on the lowest, or fifty-foot terrace, at the eastern limit of the hill. (See map, Plate XXIII.)

This terrace extends from a point about one-half mile east of the Point Fermin lighthouse to a bluff about a half mile north of the business center of the town of San Pedro. The sea cliff bounding this terrace runs due north for nearly a mile and a half from Point Fermin, then bends abruptly at old San Pedro, popularly known as "Crawfish George's," and runs northeastward for half a mile to Timm's Point. From this point the bluff runs due north for over a mile, broken only by a little valley in which the business portion of San Pedro is located. At the north end of this bluff the escarpment bends sharply toward the northwest, and is broken along the northern front by several valleys that run down from San Pedro Hill.

Half a mile southeast of Timm's Point is Deadman Island, a small fragment of the San Pedro terrace, which has withstood the eroding agents that have cut it off from the mainland, but which is now being worn away rapidly by the waves. It is a triangular bit of land about fifty feet high, with an area on top of about three hundred square yards. Deadman Island is joined by a breakwater to Rattlesnake Island, or Terminal Island, as it is now called, a narrow barrier beach, which begins at a point directly opposite San Pedro and runs to Old River—the former mouth of the Los Angeles River—about four miles distant.

About a mile east from Old River a ten-foot bank forms the eastern limit of the marsh lands and the western edge of a plain that rises toward the east for about three and a quarter miles, where it is terminated by a bluff. The bluff, which forms the coast-line of this plain, gradually rises in height from ten feet at its western extremity to over fifty feet at about its middle. The eastern half is of a nearly uniform height of fifty feet.

The town of Long Beach is situated on the plain that slopes gradually back

from this bluff. Two and a half miles north of Long Beach is Los Cerritos, or Signal Hill, as it is commonly called, the most prominent point in a series of low hills extending to Dominguez Hill, six miles to the northwest. Los Cerritos is three hundred and sixty-four feet high. Its northern side is smooth and slopes gently into the great Los Angeles plain. Its southern slope is much steeper, and is cut by many deep, narrow ravines, which offer a fine opportunity for studying the geology of the hill.

## 2. General Geology.

The oldest formation exposed in the immediate vicinity of San Pedro is the Miocene, or Monterey series. The shales of this formation are exposed along the sea cliff on the eastern end of San Pedro Hill, and also at Deadman Island. After the deposition of the Miocene the shale beds were raised and contorted and subjected to erosion. During the Pliocene period a submergence took place and a deposit of fine, yellow, clayey sand of unknown thickness was laid down on the surface of the eroded Miocene shales.

A post-Pliocene uplift laid bare the sandstones, which were worn away completely from some parts of the eastern base of San Pedro Hill. Timm's Point and Deadman Island are the only places at which they are now exposed.

Again there was a change of conditions. The eroded surface of the Pliocene became sea bottom, and deposits of fine, gray, silicious sand, extremely fossiliferous in places, were laid down unconformably on it. This particular horizon is represented by the gray sand deposit of Deadman Island, by the gray, sandy strata exposed along the bluff southeast of San Pedro and in the lower part of the continuation of this bluff just north of the San Pedro valley. The lower series of sandstones and conglomerates of Los Cerritos may be contemporaneous with these last mentioned beds. On account of its fauna and its unconformable position on the Pliocene this horizon is thought to be of Pleistocene age. It is called in this paper the lower San Pedro series. The maximum thickness of this particular horizon, so far seen, does not exceed fifty feet.

After the lower San Pedro there was a period of shallow water, lagoon and dune conditions prevalent along this part of the coast, during which the conglomerates of Deadman Island, San Pedro and Los Cerritos were laid down, and the sandy formations in the bluffs one-half mile north of San Pedro and along the Long Beach water front were deposited. This period was one of rapidly changing conditions, as is shown by sand-dune deposits and by the nearly horizontal aqueous deposits of both fine sand and gravels in alternating beds. These beds dip gently away from the centers of uplift, and many of the strata are very fossiliferous. This series of strata is called the upper San Pedro series. The maximum thickness of the strata of this horizon is over fifty feet, as is shown by the exposure in the sea-cliff southeast of Long Beach.

Overlying all these deposits is the alluvial soil, varying in depth from two to ten feet, mostly adobe, and filled in some places, notably along the San Pedro bluffs and Deadman Island, with the shells of edible mollusks. These refuse heaps, or ancient kitchen-middens, are abundant on this part of the coast.

## Correlation Table of the Marine Pliocene and Pleistocene of California.

(Dotted lines indicate conformable strata; full lines, nonconformable.)

| Epoch | Pliocene | | Pleistocene | | | Maximum thickness |
|---|---|---|---|---|---|---|
| Formation. | Merced Series | | San Pedro Series | | Recently Raised Beaches | |
| | San Diego Formation | | | | | |
| | Lower | Upper | Lower | Upper | | |
| San Diego Section. | San Diego well 150′ | | Russ School 50′ | Foot of 26th St. 20′ | | Pleistocene 70′ Pliocene 180′ |
| | | | Wanting. | Spanish Bight 20′ | | |
| | Pacific Beach (lower horizon) 180′+ | | Pac. Beach (upper horizon) 20′± | Pacific Beach 15′ | | |
| San Pedro Section. | Deadman Island 45′ | Wanting. | Deadman Island 12′ | Deadman Island 10′ | Deadman Is. 4′ | Pleistocene 100′ Pliocene 50′ |
| | Timm's Point 50′ | | San Pedro Bluffs 50′ | Lumber yard 20′ | | |
| | | | | Crawfish George's 3′ | | |
| | | | Los Cerritos 50′+ | Los Cerritos 20′ | | |
| | | | | Long Beach 50′ | | |
| Ventura Section. | Old irrigating ditch (?) | | | Old irrigating ditch 1000′± | | Pleistocene 1000′+ |
| | | | | Barlow's Ranch 100′+ | | |
| Santa Barbara Section. | Packard's Hill 200′+ | | Bluff at bath house 30′ | Bluff ¼ mile west of bath house 25′ | | Pleistocene 60′ Pliocene 200′ |
| | | | | Bluff 2 miles east of wharf 30′ | | |
| Lake Merced Section | Lake Merced to Mussel Rock below "upper gastropod bed." 5000′± | | "Upper gastropod bed" to unconformity. 150′± | "Terrace formation." Soft sediments above unconformity. 200′± | | Pleistocene 350′+ Pliocene 5000′+ |
| Other Localities | San Juan Capistrano | | | Newport, Orange County. | Blakeley, Washington 16′ | Pleistocene (Bell Station) 1320′ |
| | | | | Bell Station, Los Angeles County 1320′ | | |
| | | | Port Los Angeles, fossiliferous bed 50′± | Port Los Angeles, upper soft strata 150′± | | |
| | | | | San Pablo Bay, oyster beds | | |

### 3. Pliocene.

*Deadman Island.*—Overlying the Miocene shale of Deadman Island (see diagram *B*, Pl. XXII) is a deposit of brown, clayey sandstone, varying in thickness from twenty to forty-five feet. The distinct strata of this formation will be described in detail. The surface of jointed shale on which the sandstone rests is worn and uneven, but the contact conforms nearly to the dip of the shale, which is between 20° and 30° northeast. Other evidence beside the worn condition of the shales at the contact goes to show that the erosion took place while the shales formed the sea bottom near the shore. Worm borings are common, and in one place a pholas hole was found in the shale. The contact stratum, which is only about a foot thick, is composed almost wholly of beach-worn pebbles of the Miocene shale, all containing to some extent holes of worms and mollusks. It contains also many well preserved shells and shell fragments. All of the fossils common in this layer are found in the sandstone just above it, so its fauna will be taken up with that of the overlying sandstone in a later part of this paper.

This bottom Pliocene layer dips northeast at an angle of about 25°. Towards the top of the formation the bedding planes become more nearly horizontal, those at the top having a dip of only 8° or 10°. This could be accounted for in one of two ways—either the lowest layer was deposited horizontally and then during the deposition of the subsequent layers there was a gradual uplift toward the southwest, or else the lowest layer was deposited on a sloping bottom, and the general tendency of sediments to settle in the lower portions of their basins and to form horizontal beds gradually overcame the dip.

About eight feet of fine, brownish yellow, clayey sand rests on the pebbly lowest Pliocene stratum. In some of the places exposed to the action of the sea-water this second Pliocene stratum consists of bluish gray clay, and in some places is filled with well preserved fossils. In the southwest corner of the island the second layer is a hard, fine, brown sandstone containing only a few fossils.

Overlying the second stratum is a fine, dark brown sandstone about four feet thick. The most fossiliferous places are hard, but porous. The fossils in these hard places are well preserved, while those in the softer parts of the layer, which is lighter colored, are poorly preserved and fragile. Pieces of the hard portions of the Pliocene stratum have broken off and have fallen among the fragments of shale along the beach. This has caused some people to report the fossils found in this Pliocene bed as occurring in the Miocene shale. On account of the great abundance of *Thyasira (Cryptodon) bisecta* in this stratum it has been given the local name of "Cryptodon bed." *Lucina acutilineata* is also very common in the Cryptodon stratum.

Above this very fossiliferous stratum is a bed of brown sandstone from twenty-five to thirty-five feet in thickness, only slightly laminated, and varying somewhat in structure and appearance in different parts of the layer. The lower part is uniformly soft, while toward the top the color is lighter and the rock much harder. Only a few fossils, such as *Lucina acutilineata* and *Pecten caurinus*, have been found in the upper brown sandstone stratum. The total thickness of the Pliocene beds at Deadman Island is about forty-five feet.

## List of Species Found in the Pliocene of Deadman Island.

(P indicates species living at San Pedro; N indicates species found living only north of San Pedro; E indicates extinct species or those not known as living.)

### PELECYPODA.

*Callista subdiaphana*, N
*Chama pellucida*, P
*Corbula luteola*, P
*Cumingia californica*, P
*Kellia laperousii*, P
*Leda taphria*, P
*Lucina acutilineata*, P
*Lucina californica*, P
*Lyonsia californica*, P
*Macoma inquinata*, P
*Mytilimeria nuttalli*, P
*Nucula castrensis*, P
*Panomya ampla*, N
*Panopea generosa*, P
*Pecten caurinus*, N
*Pecten hastatus*, P
*Pecten hericeus*, N.
*Pecten jordani*, E
*Pecten stearnsii*, E
*Pholadidea penita*, P
*Protocardia centifilosa*, P
*Solen sicarius*, P
*Thracia trapezoides*, E
*Thyasira bisecta*, N
*Thyasira gouldii*, P
*Venericardia barbarensis*, P
*Venericardia ventricosa*, N
*Venus simillima*, P

### GASTROPODA.

*Acmæa insessa*, P
*Amphissa corrugata*, P
*Bela fidicula*, N
*Bittium asperum*, P
*Calliostoma canaliculatum*, P
*Calliostoma tricolor*, P
*Cerithidea californica*, P
*Chlorostoma brunneum*, P
*Chlorostoma montereyi*, P
*Chrysodomus* sp. indet., N
*Chrysodomus rectirostris*, N
*Chrysodomus tabulatus*, P.
*Clathurella conradiana*, E
*Columbella gausapata*, P
*Columbella* var. *carinata*, P
*Conus californicus*, P
*Cryptochiton stelleri*, N
*Drillia merriami*, E
*Drillia torosa*, P
*Fusus barbarensis*, E
*Hipponyx antiquatus*, P
*Littorina planaxis*, P
*Mangilia sculpturata*, P
*Nassa californiana*, P
*Nassa fossata*, P
*Nassa mendica*, P
*Nassa* var. *cooperi*, P
*Nassa perpinguis*, P
*Natica clausa*, N
*Neverita recluziana*, P
*Ocinebra interfossa*, P
*Olivella biplicata*, P
*Olivella intorta*, P
*Olivella pedroana*, P
*Pleurotoma bartschi*, E
*Pleurotoma dalli*, E
*Pleurotoma perversa*, P
*Pleurotoma renaudi*, E
*Pleurotoma smithi*, E
*Priene oregonensis*, P
*Puncturella cucullata*, N
*Puncturella galeata*, N
*Scala indianorum*, P
*Solariella cidaris*, P
*Solariella peramabilis*, P
*Taranus strongi*, E
*Terebra simplex*, P
*Thalotia caffea*, P
*Tornatina eximia*, P
*Trophon gracilis*, P
*Trophon scalariformis*, N
*Trophon stuarti*, N
*Trophon* var. *præcursor*, E
*Trophon tenuisculpta*, E
*Turritella cooperi*, P
*Turritella jewetti*, E

### BRACHIOPODA.

Bryozoan remains, ?
*Laqueus jeffreysi*, N
*Terebratalia smithi*, E

### Resumé.

| | |
|---|---|
| Total number of species | 87 |
| Pelecypoda, species | 28 |
| Gastropoda, species | 56 |
| Brachiopoda, species | 2 |
| Bryozoa, species | ? |
| Species now living at San Pedro | 55 |
| Percentage of the whole fauna | 63.1 |
| Species living only north of San Pedro | 16 |
| Percentage of the whole fauna | 18.5 |
| Species living only south of San Pedro | 0 |
| Percentage of the whole fauna | 0 |
| Species extinct or not known as living | 15 |
| Percentage of the whole fauna | 17.3 |
| Species of questionable habitat | 1 |
| Percentage of the whole fauna | 1.2 |

The fauna of the San Pedro Pliocene is a decidedly northern or boreal one in the sense that many of the species found in the San Pedro Pliocene are living now only in the colder waters far to the north of San Pedro. The large percentage of the living species found now living only north of San Pedro shows this; and in addition, the species in this fauna still living at San Pedro are nearly all of a northern or boreal type. No characteristic southern species are found in this fauna.

The evidence shows that the climate in the vicinity of San Pedro during that part of the Pliocene epoch in which these beds were deposited was probably different from the present one. A boreal fauna deposited in comparatively shallow water near the shore implies a boreal climate, at least in proximity to the coast; the fauna contains so many shallow water species, and the lithologic evidence showing that the deposits containing the fauna were laid down near the shore is so strong, that it cannot be regarded as a deep-water temperate fauna. The evidence, then, shows that during upper Pliocene times the climate of this part of Southern California was colder than at present; and if this was true of southern California, it seems reasonable to infer that the colder climate affected the whole coast from San Pedro northward.

There are several reasons for calling the lower sandstone strata of Deadman Island Pliocene. In the first place, 17.3 per cent. of the fauna of these strata are extinct at the present time. This is conclusive evidence that the beds are not Pleistocene, but are of an earlier epoch. They are overlain unconformably by strata of Pleistocene age, which implies that there was a period of denudation between the epoch of the deposition of the lower beds and the Pleistocene. Besides, these strata rest unconformably upon the Miocene shales. That the Deadman Island Pliocene beds are of upper Pliocene origin is shown by the fact that their fauna gradually grades into the living fauna of San Pedro through that of the overlying Pleistocene beds. The gap between the faunas of the Deadman Island Pliocene and the overlying Pleistocene beds, though distinct, is not wide.

In his correlation paper on the Neocene, Dr. Dall says:[1] "It appears that on Deadman Island near Point Fermin at least three distinguishable strata appear, the uppermost of which is certainly Pleistocene, while the others are Neocene and the middle layer probably Pliocene." The middle layer referred to is the brown sandstone which rests on the Miocene shales.

The Deadman Island Pliocene beds are lithologically and faunally similar to the Pliocene beds at San Diego, and have been correlated with them by Dr. Dall.[2] In the same table he places the San Diego beds below the Merced series. This does not accord with the evidence offered by the San Pedro Pliocene strata. The San Pedro beds are very near the top of the Pliocene, and have a northern fauna; the relative position of the Merced series is uncertain, and it has a fauna containing such southern forms as *Arca* and *Dosinia*, with an echinoderm, *Scutella interlineata*, which has never been found in either the San Diego or San Pedro formations, or in any formation overlying the Merced series. The Merced series has been subject to

[1] Correlation Papere, Neocene. By W. H. Dall and G. D. Harris. Bull. U. S. Geol. Sur., No. 84, 1892, p. 216.
[2] North American Tertiary Horizons. By W. H. Dall. 18th Ann. Rep. U. S. Geol. Sur., Part II, 1898, p. 335.

much more contortion than either the Deadman Island or San Diego Pliocene. The Pliocene age of the Merced series is unquestioned, and it has too great a vertical development to allow of its coming between the Pleistocene and the Deadman Island formation, which is at or near the top of the Pliocene. In the light of this evidence, it is the writer's opinion that the Deadman Island and San Diego Pliocene are above the greater part of the Merced series.

*Timm's Point.*—The Pliocene is also exposed at Timm's Point (see diagram *D*, pl. XXII), where it is similar in every respect to the Deadman Island Pliocene, except that the layers are not so distinctly separated as at Deadman Island, and, as a whole, the rocks are not so hard as at the latter place. The Miocene shales at Timm's Point dip northeast at an angle of about 25°; and resting on them in the same relative position as at Deadman Island, is the Pliocene sandstone. The Pliocene is also visible in the railroad cut in the bluff in the southeastern part of San Pedro, where there is a stratum containing numerous specimens of *Thracia trapezoides*. The beds along this cut dip gently in a northerly direction, and are overlain in the cut and to the north of it by the lighter colored Pleistocene sands.

The following species were found in the Pliocene deposits at Timm's Point and in the northward continuation of the same strata in the railroad cut and grade:

LIST OF SPECIES FOUND IN THE PLIOCENE AT TIMM'S POINT.

PELECYPODA.

| | | |
|---|---|---|
| *Callista subdiaphana* | *Pecten jordani* | *Thracia trapezoides* |
| *Leda taphria* | *Protocardia centifilosa* | *Thyasira gouldii* |
| *Lucina acutilineata* | *Solen sicarius* | *Venericardia barbarensis* |
| *Nucula castrensis* | *Thyasira bisecta* | *Venericardia ventricosa* |
| *Pecten caurinus* | | |

GASTROPODA.

| | | |
|---|---|---|
| *Bittium asperum* | *Drillia torosa* | *Natica clausa* |
| *Chrysodomus tabulatus* | *Fusus barbarensis* | *Olivella biplicata* |
| *Columbella gausapata* | *Nassa mendica* | *Terebra simplex* |
| *Columbella* var. *carinata* | *Nassa cooperi* | *Trophon stuarti* |
| *Conus californicus* | *Nassa perpinguis* | *Turritella cooperi* |

This fauna contains a total of twenty-eight species, of which thirteen are pelecypods and fifteen are gastropods. The fauna, so far as known, is small, not because the beds at that place are barren of fossils, but because little collecting has been done there. The beds are nearly covered with detritus, so that fossils are not easily obtained.

An outcrop of rather hard, fine grained sandstone on the coast about three and one-half miles east of Long Beach has some of the lithologic characters of the Deadman Island Pliocene beds. Although a few fragments of shells were seen in it, no recognizable fossils were obtained from this outcrop, and no definite correlation will therefore be attempted. It may be only a local hardening of the upper San Pedro strata.

### 4. PLEISTOCENE.

*The San Pedro Series.*—From the evidence brought forward in this paper it appears probable that most of the Pleistocene, as developed on the coast of California,

is represented by the strata of San Pedro and Deadman Island. The writer, therefore, proposes the name San Pedro Series for the series of Pleistocene strata at San Pedro, including the lower and upper formations, as described in the present paper.

*Lower San Pedro Series.*—A stratum of gray sandstone rests unconformably on the brown Pliocene sandstone of Deadman Island. (See diagram *B*, Pl. XXII.) In some places the sand is soft; in others it has been cemented until it is very hard. The soft parts are not fossiliferous, as a rule, while the hard parts are made up in some places almost wholly of beautifully preserved fossils. One locality in particular on the west side of the island, near the north end, is filled with finely preserved specimens. Parts of this bed are very hard, making it almost impossible to get the shells out, while other parts are so soft that the shells can be removed from the matrix with the fingers. This stratum varies in thickness from four to ten feet on the west side to nearly twenty feet on the east side of the island. There seems to be little indication of bedding planes in this stratum. The general dip is to the north. On account of its lying unconformably on the Pliocene, being of different lithological composition, and containing a fauna of which a great number of species have never been found in the Pliocene, this horizon is designated in the present paper as the lower San Pedro series, or the lower part of the Pleistocene. The following species have been obtained from the lower San Pedro gray sand stratum of Deadman Island:

LIST OF THE FOSSILS OF THE LOWER SAN PEDRO BEDS (LOWER PLEISTOCENE) OF DEADMAN ISLAND.

(P indicates species living at San Pedro; N indicates species living only north of San Pedro; S indicates species living only south of San Pedro; E indicates extinct species or those not known as living.)

PELECYPODA.

*Angulus buttoni*, P
*Anomia lampe*, P
*Bornia retifera*, N
*Callista* var. *pedroana*, E
*Cardium corbis*, N
*Cardium procerum*, S
*Chama pellucida*, P
*Clidiophora punctata*, P
*Cooperella subdiaphana*, P
*Corbula luteola*, P
*Cryptomya californica*, P
*Cumingia californica*, P
*Diplodonta orbella*, P
*Donax californica*, P
*Donax lævigata*, P
*Kellia laperousii*, P
*Kellia suborbicularis*, P
*Kennerlia bicarinata*, N
*Kennerlia filosa*, N
*Lævicardium substriatum*, P
*Lazaria subquadrata*, P
*Leda fossa*, N
*Leda hamata*, P
*Leda* var. *præcursor*, N
*Leda taphria*, P
*Lima dehiscens*, P
*Lucina acutilineata*, P
*Lucina californica*, P
*Lucina nuttalli*, P
*Lyonsia californica*, P
*Macoma calcarea*, N
*Macoma inquinata*, P
*Macoma nasuta*, P
*Macoma secta*, P
*Macoma yoldiformis*, P
*Mactra falcata*, P
*Metis alta*, P
*Modiola fornicata*, N
*Modiola recta*, P
*Moerella salmonea*, N
*Mytilus edulis*, P
*Mytilimeria nuttalli*, P
*Neæra pectinata*, P
*Nucula castrensis*, P
*Nucula suprastriata*, N
*Ostrea lurida*, P
*Panopea generosa*, P
*Pecten caurinus*, N
*Pecten hastatus*, P
*Pecten hericeus*, N
*Pecten* var. *strategus*, N
*Pecten jordani*, E
*Pecten latiauritus*, P
*Pecten* var. *monotimeris*, P
*Petricola carditoides*, P
*Petricola denticulata*, S
*Protocardia centifilosa*, P
*Psephis salmonea*, N
*Psephis tantilla*, N
*Raeta undulata*, P
*Saxidomus aratus*, P
*Semele* var. *montereyi*, N
*Septifer bifurcatus*, P
*Siliqua lucida*, P
*Solen rosaceus*, P
*Solen sicarius*, P
*Tapes staminea*, P
*Tellina bodegensis*, P
*Tivela crassatelloides*, P
*Venericardia barbarensis*, P
*Venericardia ventricosa*, N
*Venus simillima*, P
*Verticordia novemcostata*, P
*Yoldia scissurata*, P

## GASTROPODA.

*Acmæa insessa*, P
*Acmæa pelta*, P
*Acmæa spectrum*, P
*Actæon punctocœlata*, P
*Admete gracilior*, E
*Amphissa corrugata*, P
*Amphissa ventricosa*, E
*Amphissa versicolor*, P
*Bela fidicula*, N
*Bela sanctæ-monicæ*, E
*Bittium asperum*, P
*Bittium californicum*, E
*Bittium filosum*, N
*Bittium quadrifilatum*, P
*Bittium rugatum*, P
*Cœcum californicum*, P
*Cœcum crebricinctum*, P
*Cœcum magnum*, ?
*Calliostoma canaliculatum*, P
*Calliostoma costatum*, P
*Cerithidea californica*, P
*Chlorostoma funebrale*, P
*Chlorostoma* var. *subapertum* P
*Chlorostoma montereyi*, P
*Chlorostoma* var. *ligulatum*, P
*Chrysodomus rectirostris*, N
*Chrysodomus tabulatus*, P
*Clathurella conradiana*, E
*Clipidella bimaculata*, N
*Clipidella callomarginata*, P
*Columbella californiana*, P
*Columbella chrysalloidea*, P
*Columbella gausapata*, P
*Columbella* var. *carinata*, P
*Columbella oldroydi*, E
*Columbella tuberosa*, P
*Conus californicus*, P
*Crepidula aculeata*, P
*Crepidula adunca*, P
*Crepidula dorsata*, P
*Crepidula navicelloides*, P
*Crepidula onyx*, S
*Crepidula rugosa*, P
*Cryptochiton stelleri*, N
*Cylichna alba*, P
*Cythara branneri*, E
*Diastoma*, sp. indet., ?
*Drillia cancellata*, N
*Drillia hemphilli*, S
*Drillia inermis*, P
*Drillia merriami*, E
*Drillia montereyensis*, N
*Drillia* var. *penicillata*, P
*Drillia torosa*, P
*Eulima falcata*, S
*Eulima hastata*, S
*Eulima micans*, P
*Eupleura muriciformis*, S
*Fissuridea aspera*, P
*Fissuridea murina*, P
*Fissurella volcano*, P
*Fusus barbarensis*, E
*Fusus luteopictus*, P
*Fusus robustus*, P
*Fusus rugosus*, P
*Galerus mammillaris*, P
*Hipponyx antiquatus*, P
*Hipponyx cranioides*, N
*Hipponyx tumens*, P
*Isapis fenestrata*, P
*Ivara terricula*, ?
*Lacuna compacta*, N
*Lacuna porrecta*, N
*Lacuna solidula*, P
*Lamellaria stearnsii*, P
*Leptothyra bacula*, P
*Leptothyra carpenteri*, P
*Leptothyra paucicostata*, N
*Littorina planaxis*, P
*Littorina scutulata*, P
*Mangilia angulata*, N
*Mangilia* var. *pedroana*, E
*Mangilia interlirata*, P
*Mangilia oldroydi*, E
*Mangilia painei*, E
*Margarita* var. *nodosus*, P
*Margarita* var. *pedroana*, P
*Marginella jewetti*, P
*Melampus olivaceus*, P
*Mitramorpha filosa*, P
*Mitramorpha intermedia*, E
*Monoceros engonatum*, P
*Murex festivus*, P
*Nassa californiana*, P
*Nassa fossata*, P
*Nassa mendica*, P
*Nassa* var. *cooperi*, P
*Nassa perpinguis*, P
*Nassa tegula*, P
*Natica clausa*, N
*Neverita recluziana*, P
*Ocinebra barbarensis*, P
*Ocinebra interfossa*, P
*Ocinebra* var. *aspera*, N
*Ocinebra* var. *cerritensis*, E
*Ocinebra* var. *munda*, N
*Ocinebra perita*, P
*Ocinebra poulsoni*, P
*Odostomia gouldii*, P
*Odostomia* var. *avellana*, N
*Olivella biplicata*, P
*Olivella intorta*, P
*Olivella pedroana*, P
*Phasianella compta*, P
*Pleurotoma bartschi*, E
*Pleurotoma dalli*, E
*Pleurotoma hooveri*, E
*Pleurotoma pedroana*, E
*Pleurotoma perversa*, P
*Pleurotoma renaudi*, E
*Pleurotoma smithi*, E
*Priene oregonensis*, P
*Puncturella cucullata*, N
*Puncturella galeata*, N
*Scala hindsii*, P
*Scala indianorum*, P
*Scala tincta*, P
*Seila assimilata*, P
*Serpulorbis squamigerus*, P
*Styliferina tenuisculpta*, ?
*Taranis strongi*, E
*Terebra simplex*, P
*Thalotia caffea*, P
*Tornatina cerealis*, P
*Tornatina culcitella*, P
*Triforis adversa*, N
*Trophon cerritensis*, E
*Trophon gracilis*, P
*Trophon multicostatus*, N
*Trophon pedroana*, E
*Trophon scalariformis*, N
*Trophon stuarti*, N
*Trophon* var. *præcursor*, E
*Trophon triangulatus*, P
*Turbonilla adleri*, E
*Turbonilla arnoldi*, E
*Turbonilla aurantia*, P
*Turbonilla crebrifilata*, P
*Turbonilla gibbosa*, P
*Turbonilla laminata*, P
*Turbonilla lowei*, E
*Turbonilla muricata*, P
*Turbonilla pentalopha*, P
*Turbonilla similis*, P
*Turbonilla subcuspidata*, S
*Turbonilla tenuicula*, P
*Turbonilla torquata*, N
*Turbonilla* var. *stylina*, N
*Turbonilla tridenta*, N
*Turritella cooperi*, P
*Turritella jewetti*, E
*Vermicularia*, sp. indet., ?
*Vitrinella williamsoni*, P
*Volvarina varia*, P
*Volvula cylindrica*, P

## SCAPHOPODA.

*Cadulus nitentior*, ?
*Dentalium hexagonum*, P
*Dentalium indianorum*, N
*Dentalium pseudohexagonum*, ?

ECHINOIDEA.

*Echinarachnius excentricus*, P *Strongylocentrotus franciscanus*, P *Strongylocentrotus purpuratus*, P

CRUSTACEA.

*Cancer breweri*, E

RESUMÉ.

| | |
|---|---|
| Total number of species | 247 |
| Pelecypoda, species | 74 |
| Gastropoda, species | 165 |
| Scaphopoda, species | 4 |
| Echinoidea, species | 3 |
| Crustacea, species | 1 |
| Species living at San Pedro | 158 |
| Percentage of fauna | 64 |
| Species living only north of San Pedro | 43 |
| Percentage of fauna | 17.4 |
| Specimens living only south of San Pedro | 8 |
| Percentage of fauna | 3.2 |
| Species extinct | 31 |
| Percentage of fauna | 12.5 |
| Species of questionable habitat | 7 |
| Percentage of fauna | 3 |

This is also a cold water fauna. Not only is there a large percentage of species which are found living only north of San Pedro at the present time, but of those species in the fauna which are now living at San Pedro, a great many are northern forms. A few distinctly southern forms are found in the fauna, however, which shows that the cold climatic conditions prevalent along this part of the coast during the upper Pliocene times were beginning to give place to more temperate conditions in the early part of the Pleistocene. The fauna of the lower San Pedro series is a transitional one between the boreal fauna of the Pliocene and the warm water fauna of the upper San Pedro series. The climatic conditions were therefore changing during lower Pleistocene times; and the climate at the end of the period of deposition of the lower San Pedro deposits was much warmer than that at the end of the period of deposition of the Pliocene. The period of denudation between the Pliocene and Pleistocene epochs was one during which the conditions were also changing.

The lower San Pedro deposits are thought by the writer to be of Pleistocene origin, for several reasons. First, we have a fauna with a low percentage of extinct species. (The high percentage of the list given above is due to the large number of new species and varieties, many of which are close to living forms and are probably living, but which have not been reported.) The large number of species found in this fauna which have never been found in beds of known Pliocene origin, and the lack of several of the typical Pliocene species from its fauna, offer two of the strongest arguments in favor of the Pleistocene age of the lower San Pedro series. The state of preservation of the fossils is also an item in favor of their comparatively recent deposition. It is worthy of note that in several cases the original coloration of the shells of lower San Pedro fossils is still preserved. The sands, too, of this formation are always much less oxidized than those of the underlying Pliocene. An unconformity between this formation and the Pliocene also suggests a lapse of time between the two.

Dr. Lawson in discussing the movements that have taken place during late Tertiary and Pleistocene times in the vicinity of San Pedro, says :[1] "It follows that, while there is a very profound physical break between the Miocene and Pliocene, the marine Pliocene and Pleistocene formations are intimately associated, with no epoch of subaërial denudation between them." The observations of the writer also show this to be true, although in some places there is evidence of local denudation between the Pliocene and Pleistocene. At Deadman Island, in particular, there is evidence of a period of denudation between the two.

Beds of a fine gray sand, with gentle north dip, rest upon the Pliocene exposed along the railroad grade leading up to the cut in the bluff in the southeastern portion of San Pedro. (See diagram *D*, Pl. XXII.) The exact relation between these gray sands and the underlying Pliocene is uncertain, as detritus covers the contact along the face of the bluff. But the gray sand beds seem to rest almost conformably on the yellow Pliocene deposits, both having a low dip toward the north. One of the layers of gray sand near the top of the bluff north of the railroad grade contains a fauna similar to that of the lower San Pedro stratum of Deadman Island. This stratum is exposed in the bluff to the north of the San Pedro valley, and also in two small cuts in the bluff west of the business portion of the town. These gray sand strata were continuous at one time, the San Pedro valley, which cuts them, having been formed by recent erosion.

In the bluff to the north of the valley the fossiliferous lower San Pedro stratum is about forty feet above tide level and dips northward, disappearing under detritus at the mouth of a small ravine about three hundred yards from the southern end of the bluff, but appearing again north of the ravine at the base of the bluff. Underlying this lower San Pedro bed are gray sandy strata which correspond to the lower part of this same formation south of the valley, and which are unfossiliferous, except in a few places. The following fossils have been found in the lower San Pedro beds in the San Pedro bluffs.

### List of Fossils of the Lower San Pedro Beds at the San Pedro Bluffs.

#### PELECYPODA.

*Angulus buttoni*
*Anomia lampe*
*Cardium corbis*
*Corbula luteola*
*Cryptomya californica*
*Cumingia californica*
*Donax californica*
*Donax lævigata*
*Hinnites giganteus*
*Kellia laperousii*
*Kellia suborbicularis*
*Lævicardium substriatum*
*Lazaria subquadrata*
*Leda* var. *præcursor*
*Leda taphria*
*Lucina acutilineata*
*Lucina californica*
*Lucina nuttalli*
*Lyonsia californica*
*Macoma nasuta*
*Macoma secta*
*Macoma yoldiformis*
*Mactra falcata*
*Mytilimeria nuttalli*
*Nucula castrensis*
*Nucula suprastriata*
*Ostrea lurida*
*Pecten latiauritus*
*Pecten* var. *monotimeris*
*Psephis salmonea*
*Psephis tantilla*
*Semele decisa*
*Siliqua lucida*
*Solen rosaceus*
*Solen sicarius*
*Tapes staminea*
*Tellina bodegensis*

[1] Post-Pliocene Diastrophism of the Coast of Southern California. By A. C. Lawson. Bull. Dept. Geol., Univ. of California Vol. 1, 1893, p. 128.

GASTROPODA.

*Acmæa insessa*
*Actæon punctocælata*
*Bittium filosum*
*Bittium quadrifilatum*
*Bittium rugatum*
*Cæcum californicum*
*Cæcum crebricinctum*
*Cæcum magnum.*
*Calliostoma canaliculatum*
*Calliostoma costatum*
*Calliostoma tricolor*
*Cerithidea californica*
*Chlorostoma funebrale*
*Chlorostoma* var. *subapertum*
*Chlorostoma* var. *ligulatum*
*Chrysodomus tabulatus*
*Clathurella conradiana*
*Clipidella bimaculata*
*Clipidella callomarginata*
*Columbella californiana*
*Columbella chrysalloidea*
*Columbella gausapata*
*Columbella* var. *carinata*
*Columbella tuberosa*
*Conus californicus*
*Crepidula aculeata*
*Crepidula adunca*
*Crepidula navicelloides*
*Crepidula onyx*
*Crucibulum spinosum*
*Drillia hemphilli*
*Drillia* var. *penicillata*
*Drillia torosa*
*Eulima micans*
*Fissuridea aspera*
*Fissurella volcano*
*Galerus mammillaris*
*Hipponyx cranioides*
*Hipponyx tumens*
*Isapis fenestrata*
*Lacuna porrecta*
*Leptothyra carpenteri*
*Littorina planaxis*
*Littorina scutulata*
*Mangilia angulata*
*Margarita* var. *knechti*
*Margarita* var. *nodosus*
*Margarita* var. *pedroana*
*Marginella jewetti*
*Melampus olivaceus*
*Mitra maura*
*Monoceros engonatum*
*Nassa fossata*
*Nassa mendica*
*Nassa* var. *cooperi*
*Nassa perpinguis*
*Nassa tegula*
*Neverita recluziana*
*Ocinebra barbarensis*
*Ocinebra interfossa*
*Ocinebra* var. *aspera*
*Ocinebra* var. *cerritensis*
*Ocinebra poulsoni*
*Odostomia gouldii*
*Odostomia tenuis*
*Olivella biplicata*
*Olivella intorta*
*Olivella pedroana*
*Pachypoma inæquale*
*Paludestrina curta*
*Paludestrina stokesi*
*Phasianella compta*
*Physa heterostropha*
*Planorbis tumidus*
*Planorbis vermicularis*
*Pleurotoma perversa*
*Scala crebricostata*
*Scala hindsii*
*Scala indianorum*
*Scala tincta*
*Serpulorbis squamigerus*
*Taranis strongi*
*Terebra simplex*
*Tornatina cerealis*
*Tornatina culcitella*
*Trophon pedroana*
*Turbonilla aurantia*
*Turbonilla crebrifilata*
*Turbonilla laminata*
*Turbonilla lowei*
*Turbonilla muricata*
*Turbonilla similis*
*Turbonilla stearnsii*
*Turbonilla subcuspidata*
*Turbonilla tenuicula*
*Turbonilla* var. *stylina*
*Turbonilla tridenta*
*Turritella cooperi*
*Volvarina varia*

SCAPHOPODA.

*Dentalium hexagonum* *Dentalium indianorum*

CRUSTACEA.

*Balanus concavus*

ECHINOIDEA.

*Echinarachnius excentricus*

This fauna comprises one hundred and forty species, of which thirty-seven are pelecypods, ninety-nine are gastropods, two are scaphopods, one is a crustacean, and one an echinoderm. The fauna of the lower beds of the San Pedro bluffs approaches a little nearer that of the upper San Pedro series than does the fauna of the same formation on Deadman Island. This may mean that part of the lower San Pedro beds was removed from the Deadman Island deposit before the deposition of the upper Pleistocene strata.

The following species occur in the lower San Pedro deposits of the San Pedro bluffs which have not been reported from the same horizon of Deadman Island:

## List of Fossils from the Lower San Pedro Beds of the San Pedro Bluffs not found at Deadman Island.

(P indicates species living at San Pedro; N indicates species living only north of San Pedro; S indicates species living only south of San Pedro; E indicates extinct species, or species not known as living.

### PELECYPODA.

*Hinnites giganteus*, P
*Semele decisa*, P

### GASTROPODA.

*Calliostoma tricolor*, P
*Crucibulum spinosum*, P
*Margarita* var. *knechti*, E
*Odostomia tenuis*, P
*Pachypoma inæquale*, P
*Paludestrina curta*, E
*Paludestrina stokesi*, E
*Physa heterostropha*, P
*Planorbis tumidus*, S
*Planorbis vermicularis*, N
*Scala crebricostata*, P
*Turbonilla stearnsii*, S

*Upper San Pedro Series.*—Resting on the gray sandstone of the lower San Pedro series at Deadman Island is a stratum of fossiliferous gravel hardened by calcareous cement. (See Diagram *B*, Pl. XXII.) This stratum, which extends over the whole island at about six feet below the surface, is from two to three feet in thickness. The matrix varies from fine sand to water-worn pebbles of Miocene shale, many of which are full of pholas holes still containing the shell. The fossils are well preserved, and, in all but a few localities of exceptional hardness, may be removed from the matrix with the fingers. This stratum lies nearly horizontal. Water-worn boulders of the gray lower San Pedro sandstone occur in the upper San Pedro conglomerate at Deadman Island. This evidence indicates an unconformity between the lower and upper San Pedro series. Similar evidence is noticeable in the bluff north of the San Pedro valley.

## List of Fossils from the Upper San Pedro Gravel Stratum, Deadman Island.

### PELECYPODA.

*Angulus buttoni*
*Cardium corbis*
*Chama pellucida*
*Cryptomya californica*
*Cumingia californica*
*Donax lævigata*
*Glycymeris barbarensis*
*Glycymeris septentrionalis*
*Hinnites giganteus*
*Lævicardium substriatum*
*Leda taphria*
*Lucina acutilineata*
*Lucina californica*
*Lucina nuttalli*
*Lyonsia californica*
*Macoma inquinata*
*Macoma nasuta*
*Macoma secta*
*Mactra catilliformis*
*Mactra falcata*
*Metis alta*
*Modiola recta*
*Mytilus edulis*
*Panopea generosa*
*Pecten latiauritus*
*Pecten* var. *monotimeris*
*Pecten subnodosus*
*Pecten ventricosus*
*Periploma argentaria*
*Petricola carditoides*
*Pholadidea penita*
*Platyodon cancellatus*
*Pododesmus macroschisma*
*Psephis tantilla*
*Rupellaria lamellifera*
*Saxidomus aratus*
*Semele decisa*
*Solen rosaceus*
*Solen sicarius*
*Tagelus californianus*
*Tapes staminea*
*Tapes tenerrima*
*Tellina bodegensis*
*Tivela crassatelloides*
*Tresus nuttalli*
*Venus simillima*
*Venus succincta*
*Zirphæa gabbi*

### GASTROPODA.

*Acmæa insessa*
*Acmæa spectrum*
*Amphissa versicolor*
*Bittium quadrifilatum*
*Bittium rugatum*
*Bulla punctulata*
*Calliostoma canaliculatum*
*Cerithidea californica*
*Chlorostoma brunneum*
*Chlorostoma funebrale*
*Chlorostoma* var. *subapertum*
*Chlorostoma gallina*
*Chlorostoma montereyi*
*Chlorostoma* var. *ligulatum*
*Columbella gausapata*
*Columbella* var. *carinata*
*Columbella tuberosa*
*Conus californicus*

*Crepidula adunca*
*Crepidula grandis*
*Crepidula navicelloides*
*Crepidula onyx*
*Crepidula rugosa*
*Crucibulum spinosum*
*Cypræa spadicea*
*Drillia* var. *penicillata*
*Drillia torosa*
*Eupleura muriciformis*
*Fissuridea aspera*
*Fissuridea inæqualis*
*Fissuridea murina*
*Fissurella volcano*
*Fusus barbarensis*
*Fusus luteopictus*
*Fusus robustus*
*Haliotis fulgens*
*Hipponyx cranioides*
*Hipponyx tumens*
*Isapis fenestrata*
*Lacuna porrecta*
*Littorina scutulata*
*Margarita* var. *pedroana*
*Marginella jewetti*
*Melampus olivaceus*
*Mitra maura*
*Monoceros engonatum*
*Murex festivus*
*Murex trialatus*
*Nassa californiana*
*Nassa fossata*
*Nassa mendica*
*Nassa* var. *cooperi*
*Nassa perpinguis*
*Nassa tegula*
*Natica lewisii*
*Neverita recluziana*
*Norrisia norrisii*
*Ocinebra interfossa*
*Ocinebra keepi*
*Ocinebra* var. *aspera*
*Ocinebra perita*
*Ocinebra poulsoni*
*Olivella biplicata*
*Olivella intorta*
*Olivella pedroana*
*Pisania fortis*
*Pleurotoma carpenteriana*
*Pleurotoma perversa*
*Priene oregonensis*
*Purpura crispata*
*Ranella californica*
*Scala crebricostata*
*Scala hindsii*
*Scala indianorum*
*Scala tincta*
*Serpulorbis squamigerus*
*Spiroglyphus lituella*
*Terebra simplex*
*Tornatina culcitella*
*Turritella cooperi*
*Turritella jewetti*
*Volvarina varia*

CRUSTACEA.

*Balanus concavus*

ECHINOIDEA.

*Echinarachnius excentricus*

SCAPHOPODA.

*Dentalium semipolitum* *Dentalium hexagonum*

This fauna comprises one hundred and thirty-four species, of which forty-eight are pelecypods, eighty-two are gastropods, two are scaphopods, one is a crustacean, and one is an echinoderm. This fauna is not as large as that of the upper San Pedro series at the north end of the San Pedro bluff, so the discussion of the fauna will follow the list of species obtained from the latter locality.

There is a railroad cut a few feet in depth near the southwestern limit of the San Pedro terrace. (See *D*, diagram *E*, Pl. XXIII.) On both sides of this cut there is exposed a bed of gravel consisting of sand, numerous well preserved fossils, and water-worn pebbles of Miocene shale, many of which are full of pholas holes. The bed is from two to three feet thick, and rests unconformably on the upturned edges of the Miocene shale, which at this point dips northeast at an angle of about 15°. The gravel stratum dips gently toward the south, and is overlain by soil, which varies from three to five feet in thickness, growing thicker toward the south. This layer is also exposed at the top of the sea-cliff near *D*, and at many places along the top of the cliff from *D* to Timm's Point. This formation is exceptionally well developed on the sides of the ravine which cuts the bluff at Crawfish George's, showing a thickness of three feet, very fossiliferous, and, in some places, hardened by calcareous cement. The deposit at Crawfish George's is mentioned by Ashley,[1] who refers it to the Pliocene.

[1] Neocene of the Santa Cruz Mountains. By Geo. H. Ashley. Proc. Cal. Acad. Sci., 2nd Ser., Vol. V, 1894, p. 341.

## List of Fossils Collected at Crawfish George's.

### PELECYPODA.

*Angulus buttoni*
*Anomia lampe*
*Cardium corbis*
*Chama pellucida*
*Cryptomya californica*
*Cumingia californica*
*Diplodonta orbella*
*Donax lævigata*
*Glycymeris barbarensis*
*Glycymeris septentrionalis*
*Lævicardium substriatum*
*Lazaria subquadrata*
*Leda taphria*
*Lucina acutilineata*
*Lucina californica*
*Lucina nuttalli*
*Lyonsia californica*
*Macoma inquinata*
*Macoma nasuta*
*Macoma secta*
*Mactra catilliformis*
*Mactra falcata*
*Metis alta*
*Mytilus edulis*
*Ostrea lurida*
*Pecten caurinus*
*Pecten hastatus*
*Pecten latiauritus*
*Pecten* var. *monotimeris*
*Pecten ventricosus*
*Periploma argentaria*
*Petricola carditoides*
*Pholadidea penita*
*Platyodon cancellatus*
*Pododesmus macroschisma*
*Saxidomus aratus*
*Solen rosaceus*
*Solen sicarius*
*Tagelus californianus*
*Tapes staminea*
*Tapes tenerrima*
*Telina bodegensis*
*Tivela crassatelloides*
*Tresus nuttalli*
*Venericardia barbarensis*
*Venus simillima*
*Venus succincta*
*Zirphæa gabbi*

### GASTROPODA.

*Acmæa depicta*
*Acmæa insessa*
*Acmæa instabilis*
*Acmæa mitra*
*Acmæa paleacea*
*Amphissa corrugata*
*Amphissa versicolor*
*Bela fidicula*
*Bittium asperum*
*Bittium filosum*
*Bittium quadrifilatum*
*Bittium rugatum*
*Bulla punctulata*
*Cœcum crebricinctum*
*Calliostoma canaliculatum*
*Calliostoma costatum*
*Calliostoma gemmulatum*
*Calliostoma tricolor*
*Certhidea californica*
*Chlorostoma brunneum*
*Chlorostoma funebrale*
*Chlorostoma* var. *subapertum*
*Chlorostoma gallina*
*Chlorostoma montereyi*
*Chlorostoma ligulatum*
*Chorus belcheri*
*Chrysodomus rectirostris*
*Clipidella callomarginata*
*Columbella gausapata*
*Columbella* var. *carinata*
*Columbella tuberosa*
*Conus californicus*
*Crepidula dorsata*
*Crepidula navicelloides*
*Crepidula rugosa*
*Crucibulum spinosum*
*Drillia* var. *penicillata*
*Drillia torosa*
*Eulima micans*
*Fissuridea aspera*
*Fissuridea murina*
*Fissurella volcano*
*Fusus barbarensis*
*Fusus luteopictus*
*Fusus robustus*
*Galerus mammillaris*
*Isapis fenestrata*
*Lacuna porrecta*
*Leptothyra carpenteri*
*Littorina scutulata*
*Mangilia angulata*
*Mangilia* var. *pedroana*
*Marginella jewetti*
*Melampus olivaceus*
*Mitra maura*
*Monoceros engonatum*
*Murex festivus*
*Murex leeanus*
*Murex trialatus*
*Nassa cerritensis*
*Nassa fossata*
*Nassa mendica*
*Nassa* var. *cooperi*
*Nassa perpinguis*
*Nassa tegula*
*Natica lewisii*
*Neverita recluziana*
*Ocinebra interfossa*
*Ocinebra lurida*
*Ocinebra* var. *aspera*
*Ocinebra* var. *cerritensis*
*Ocinebra micheli*
*Ocinebra perita*
*Ocinebra poulsoni*
*Olivella biplicata*
*Olivella intorta*
*Olivella pedroana*
*Pachypoma inæquale*
*Phorcus pulligo*
*Pleurotoma carpenteriana*
*Pomaulax undosus*
*Priene oregonensis*
*Purpura crispata*
*Ranella californica*
*Scala indianorum*
*Scala tincta*
*Serpulorbis squamigerus*
*Spiroglyphus lituella*
*Siphonalia kellettii*
*Terebra simplex*
*Tornatina culcitella*
*Trophon pedroana*
*Trophon scalariformis*
*Turritella cooperi*
*Turritella jewetti*
*Volvarina varia*

### CRUSTACEA.

*Balanus concavus*

### ECHINOIDEA.

*Echinarachnius excentricus*

### SCAPHOPODA.

*Dentalium semipolitum*
*Dentalium indianorum*
*Dentalium hexagonum*

The fauna of Crawfish George's consists of one hundred and fifty-three species, of which forty-eight are pelecypods, one hundred are gastropods, three are scaphopods, one is an echinoderm, and one is a crustacean. It is similar to the upper fauna of the San Pedro bluff, with the exception that it affords a few species common in the lower San Pedro series that are not found in the upper beds at any other locality. Another noticeable fact is the great preponderance in numbers of gastropods over pelecypods. The fauna seems to be that of a rocky beach.

All along the cliff, from Crawfish George's to Timm's Point, the gravel lies unconformably in disconnected masses on the Miocene shale, and is covered by soil varying in depth from three to ten feet. From Timm's Point to the north along the bluff this formation is not exposed until a point is reached a little north of the railway cut. Here the typical gravel of the upper San Pedro series rests unconformably upon the lower San Pedro gray sand, and is overlain by a layer of soil. The upper San Pedro gravel (see diagram *D*, Plate XXII) again outcrops in the bluff north of the San Pedro Valley, but is covered in this bluff by a sandy stratum between it and the soil. This gravel stratum runs along the bluff near the surface until it reaches a point about two hundred yards north of the valley, where it suddenly dips at an angle of 45° for eight feet, resting all the while on the eroded surface of the lower San Pedro strata. Again changing its dip to normal, it disappears under the detritus at the mouth of a short ravine. The unconformable position of the upper gravel on the lower gray sand is very apparent a few yards south of the ravine, where fragments of the lower San Pedro strata are found in the upper gravel. After the deposition of the lower San Pedro beds there came a period of uplift, during which they were eroded; then came a period of depression, during which the upper San Pedro beds were deposited on the eroded surface of the lower series.

A heterogeneous series of strata, composed of alternating beds of sand and gravel, occurs above the gravel stratum at the ravine and to the north of it. These overlying beds dip gently to the north, but the series does not decrease in thickness to the north for the reason that other strata begin near the top of the bluff, and thus make a nearly horizontal surface to the top of the series, which is overlain by soil to the thickness of from two to ten feet. The lower strata along this bluff are of fine sand, fossiliferous in places. Near the top of the bluff, however, the strata are composed of coarse material, a distinct layer of gravel cemented with lime and containing many well preserved fossils forming the top layer. This top stratum first appears at the top of the bluff about one hundred feet south of the ravine. From this point south of the ravine it can be traced north along the bluff near the top, around the north end of the bluff, and back again on the west side of this promontory for several hundred feet. About six feet below the top gravel stratum is another layer rich in fossils. The beds below these last two are sand and gravel deposits of varying composition, nearly all, however, fossiliferous. Some of these lower strata show sand-dune bedding, while others are horizontal. This alternation of bedding would indicate a period of alternating conditions of elevation and

depression during the beginning of the epoch in which the upper San Pedro beds were deposited. The same sequence of strata as in the north end of the bluff occurs across the little valley to the west. The strata extend toward the west, but just how far it is not possible to determine. All the fossils labeled "San Pedro" and "Lumber yard" are from the upper San Pedro strata in this locality, and many fine specimens have been obtained during the past few years. A great many shiploads of material have been hauled away from the bluffs as ballast by the coaling vessels docked at the port of San Pedro.

The uppermost gravel stratum of the upper San Pedro series appears to be laid down nearly horizontally and almost continuously over the whole of the lower or fifty-foot terrace of San Pedro Hill.

The following species from the type locality of the upper San Pedro series were collected at the north end of the San Pedro bluff, near the lumber yard, one-half mile north of the valley:

### List of Fossils from the North End of the San Pedro Bluff.

(P indicates species found living at San Pedro; N indicates species found living only north of San Pedro; S indicates species found living only south of San Pedro; E indicates extinct species or those not known as living.)

#### PELECYPODA.

*Amiantis callosa*, P
*Angulus buttoni*, P
*Anomia lampe*, P
*Arca labiata*, S
*Astarte branneri*, E
*Cardium corbis*, N
*Cardium elatum*, S
*Cardium pròcerum*, S
*Cardium quadrigenarium*, P
*Chama exogyra*, P
*Chama pellucida*, P
*Clidiophora punctata*, P
*Corbula luteola*, P
*Cryptomya californica*, P
*Cumingia californica*, P
*Diplodonta orbella*, P
*Diplodonta serricata*, S
*Donax californica*, P
*Donax lævigata*, P
*Glycymeris barbarensis*, E
*Glycymeris septentrionalis*, N
*Hinnites giganteus*, P
*Lævicardium substriatum*, P
*Lazaria subquadrata*, P
*Leda taphria*, P
*Lucina acutilineata*, P
*Lucina californica*, P
*Lucina nuttalli*, P
*Lucina tenuisculpta*, P
*Lyonsia californica*, P
*Macoma indentata*, P
*Macoma inquinata*, P
*Macoma nasuta*, P
*Macoma* var. *kelseysi*, S
*Macoma secta*, P
*Mactra californica*, P
*Mactra catilliformis*, P
*Mactra exoleta*, S
*Mactra falcata*, P
*Mactra hemphilli*, E
*Metis alta*, P
*Modiola recta*, P
*Mytilus edulis*, P
*Nucula suprastriata*, N
*Ostrea lurida*, P
*Panopea generosa*, P
*Pecten dentatus*, S
*Pecten latiauritus*, P
*Pecten* var. *fragilis*, E
*Pecten* var. *monotimeris*, P
*Pecten newsomi*, E
*Pecten subnodosus*, S
*Pecten ventricosus*, P
*Periploma argentaria*, P
*Petricola carditoides*, P
*Petricola denticulata*, S
*Pholadidea penita*, P
*Platyodon cancellatus*, P
*Pododesmus macroschisma*, P
*Psammobia edentula*, ?
*Psephis tantilla*, N
*Sanguinolaria nuttalli*, P
*Saxidomus aratus*, P
*Semele decisa*, P
*Semele pulchra*, P
*Siliqua lucida*, P
*Siliqua* var. *nuttalli*, N
*Solen rosaceus*, P
*Solen sicarius*, P
*Tagelus californianus*, P
*Tapes lacineata*, P
*Tapes staminea*, P
*Tapes tenerrima*, P
*Tellina bodegensis*, S
*Tellina rubescens*, S
*Tivela crassatelloides*, P
*Tresus nuttalli*, P
*Venericardia barbarensis*, P
*Venus fluctifraga*, P
*Venus gnidia*, S
*Venus neglecta*, S
*Venus simillima*, P
*Venus succincta*, P
*Yoldia cooperi*, P
*Zirphæa gabbi*, E

#### GASTROPODA.

*Amæa insessa*, P
*Amæa pelta*, P
*Amæa spectrum*, P
*Actæon punctocælata*, P
*Actæon traskii*, S
*Amphissa corrugata*, P
*Amphissa versicolor*, P
*Bittium asperum*, P
*Bittium filosum*, P

*Bittium quadrifilatum*, P
*Bittium rugatum*, P
*Bittium williamsoni*, ?
*Bulla punctulata*, S
*Bulla quoyi*, P
*Cœcum californicum*, P
*Cœcum crebricinctum*, P
*Calliostoma annulatum*, P
*Calliostoma canaliculatum*, P
*Calliostoma costatum*, P
*Calliostoma gemmulatum*, P
*Calliostoma tricolor*, P
*Cancellaria cooperi*, P
*Cancellaria crawfordiana*, P
*Cancellaria tritonidea*, E
*Cerithidea californica*, P
*Chlorostoma aureotinctum*, P
*Chlorostoma funebrale*, P
*Chlorostoma* var. *subapertum*, P
*Chlorostoma gallina*, P
*Chlorostoma montereyi*, P
*Chlorostoma* var. *ligulatum*, P
*Chorus belcheri*, P
*Clathurella conradiana*, E
*Clipidella bimaculata*, N
*Clipidella callomarginata*, P
*Columbella chrysalloidea*, P
*Columbella gausapata*, P
*Columbella* var. *carinata*, P
*Columbella minima*, E
*Columbella* var. *præcursor*, S
*Columbella tuberosa*, P
*Conus californicus*, P
*Coralliophila nux*, S
*Crepidula aculeata*, P
*Crepidula adunca*, P
*Crepidula navicelloides*, P
*Crepidula onyx*, S
*Crepidula rugosa*, P
*Crucibulum spinosum*, P
*Cylichna alba*, P
*Drillia hemphilli*, S
*Drillia inermis*, P
*Drillia johnsoni*, E
*Drillia* var. *penicillata*, P
*Drillia pudica*, S
*Drillia torosa*, P
*Erato columbella*, P
*Eulima hastata*, S
*Eulima micans*, P
*Eupleura muriciformis*, S
*Eupleura* var. *curta*, E
*Fissuridea aspera*, P
*Fissuridea inæqualis*, S
*Fissuridea murina*, P
*Fissurella volcano*, P
*Fusus barbarensis*, E
*Fusus luteopictus*, P
*Fusus robustus*, P
*Galerus mammillaris*, P
*Haminea virescens*, P
*Helix* sp. indet., ?
*Isapis fenestrata*, P
*Ishnochiton regularis*, P
*Lacuna compacta*, N
*Lacuna porrecta*, N
*Lacuna solidula*, P
*Leptothyra carpenteri*, P
*Littorina planaxis*, P
*Littorina scutulata* P
*Macron kellettii*, S
*Mopalia ciliata*, P
*Mangilia hooveri*, E
*Mangilia striosa*, P
*Margarita* var. *knechti*, E
*Margarita* var. *pedroana*, E
*Marginella jewetti*, P
*Melampus olivaceus*, P
*Mitra maura*, P
*Monoceros engonatum*, P
*Monoceros lapilloides*, P
*Murex festivus*, P
*Murex foliatus*, N
*Murex leeanus*, S
*Murex monoceros*, S
*Murex trialatus*, P
*Nassa californiana*, P
*Nassa cerritensis*, E
*Nassa fossata*, P
*Nassa insculpta*, C
*Nassa mendica*, P
*Nassa* var. *cooperi*, P
*Nassa perpinguis*, P
*Nassa tegula*, P
*Nassa* var. *hooveri*, S
*Natica lewisii*, P
*Neverita recluziana*, P
*Ocinebra foveolata*, P
*Ocinebra interfossa*, P
*Ocinebra* var. *aspera*, P
*Ocinebra cancellina*, S
*Ocinebra perita*, P
*Ocinebra poulsoni*, P
*Odostomia tenuis*, P
*Olivella biplicata*, P
*Olivella intorta*, P
*Olivella pedroana*, P
*Opalia borealis*, P
*Pachypoma inæquale*, P
*Paludestrina curta*, E
*Paludestrina stokesi*, E
*Phasianella compta*, P
*Pisania fortis*, E
*Planorbis tumidus*, S
*Planorbis vermicularis*, N
*Pleurotoma carpenteriana*, P
*Pleurotoma cooperi*, E
*Pleurotoma perversa*, N
*Pleurotoma tryoniana*, P
*Pomaulax undosus*, P
*Priene oregonensis*, P
*Puncturella cucullata*, N
*Purpura crispata*, N
*Purpura saxicola*, P
*Pyramidella* var. *variegata*, S
*Ranella californica*, P
*Rissoa acutelirata*, S
*Scala bellastriata*, P
*Scala crebricostata*, P
*Scala hemphilli*, E
*Scala hindsii*, P
*Scala indianorum*, P
*Scala tincta*, P
*Serpulorbis squamigerus*, P
*Siphonalia kellettii*, P
*Spiroglyphus lituella*, P
*Terebra simplex*, P
*Tornatina cerealis*, P
*Tornatina culcitella*, P
*Trivia californica*, P
*Triton gibbosus*, S
*Trophon multicostatus*, N
*Turbonilla aurantia*, P
*Turbonilla laminata*, P
*Turbonilla lowei*, E
*Turbonilla stearnsii*, S
*Turbonilla subcuspidata*, S
*Turbonilla tenuicula*, P
*Turritella cooperi*, P
*Turritella jewetti*, E
*Vitrinella williamsoni*, P
*Volvarina varia*, P

CRUSTACEA.

*Balanus concavus*, P

SCAPHOPODA.

*Dentalium hexagonum*, P
*Dentalium pseudohexagonum*. ?
*Dentalium semipolitum*, S

ECHINOIDEA.

*Echinarachnius excentricus*, P

PISCES.

*Urolophus halleri*, ?

RESUMÉ.

| | |
|---|---|
| Total number of species | 252 |
| Pelecypoda | 85 |
| Gastropoda | 161 |
| Scaphopoda | 3 |
| Echinoidea | 1 |
| Crustacea | 1 |
| Pisces | 1 |
| Living at San Pedro | 172 |
| Percentage of fauna | 68.2 |
| Living only north of San Pedro | 15 |
| Percentage of fauna | 6.1 |
| Living only south of San Pedro | 36 |
| Percentage of fauna | 14.2 |
| Extinct species | 24 |
| Percentage of fauna | 9.5 |
| Questionable | 4 |
| Percentage of fauna | 1.6 |

The fauna of the upper San Pedro series as afforded by the beds near the lumber yard is of a character more nearly resembling that found living at the present time on the coast two or three hundred miles further south. Not only is there a large percentage of species now living only south of San Pedro, but of the species living at San Pedro many are southern forms. Several of the northern forms remained during the period of deposition of the upper San Pedro series, but in greatly diminished numbers. Of the extinct forms most are new species or varieties which may be found upon a more extended examination to be living. Faunal evidence leads to the conclusion, therefore, that the climatic conditions on the coast near San Pedro during the period of deposition of the upper San Pedro series were as warm, if not warmer, than those of the present time. The change from the boreal conditions of the upper Pliocene epoch to the tropical or semitropical conditions of the Pleistocene was not sudden, but took place rather gradually, as is shown by the transition fauna of the lower San Pedro deposits.

The upper San Pedro stage described in this paper is separated from the lower San Pedro deposits for the following reasons: First, there is an unconformity between these upper beds and the underlying formations at all of the localities examined. Secondly, the upper San Pedro beds differ lithologically from the lower San Pedro strata; the former being largely gravels, while the latter are of gray sand. Thirdly, the difference in the fossils of the two horizons is very marked. Many found in the lower series are not found in the upper, and many of the species in the latter are never found in the former. Fourthly, the upper series has a semi-tropical fauna, while that of the lower series approaches the semi-boreal.

The upper San Pedro beds do not represent the top of the Pleistocene. The fauna of these upper beds, although having many species in common with the living fauna of the same locality, is still quite distinct. This would suggest a period of considerable length since the deposition of the strata. The number of distinctly southern forms living at San Pedro during the period of deposition of the upper beds also shows that there has probably been a change in climatic conditions since

that time. A raised beach unconformable with the upper San Pedro strata at Deadman Island shows that there have been orographic movements since the upper San Pedro beds were deposited. All of this evidence, then, leads to the conclusion that there has been a sufficient lapse of time since the deposition of the upper San Pedro strata, to admit of marked faunal and orographic changes.

The upper San Pedro series is well developed on Los Cerritos Hill, where the typical fossiliferous gravels of the upper San Pedro formation overlie unconformably the brown, tilted sandstones which form the major portion of that hill. A little above *H* (diagram *E*, Plate XXIII), the gravel stratum has a dip of 4° due south. Below the gravel stratum is a thin bed of sand, which is also very fossiliferous. At *G* the gravel stratum is only a few feet below the surface of the hill, but near the top of the hill this stratum is covered by a deeper deposit of sands and sandy soil. The dip of the stratum at *K* is N. 85° W. at an angle of from 12° to 15°. At *K* the gravel is overlain by a deposit of fine, unfossiliferous sand four feet thick.

At all the localities on Los Cerritos Hill where the upper San Pedro beds are exposed, the underlying formation is a series of sands and conglomerates. No fossils were obtained in the underlying series of rocks, but they are probably of the lower San Pedro series.

It will be noticed, on looking at the contours on diagram *E*, Plate XXIII, and observing the dips at the different places, that the dip of the gravel stratum conforms very nearly to the slope of the hill. There is a fault at *H*, which cuts the upper San Pedro stratum. The sand deposits above the gravels in a few places are probably what is left of layers of sand which once covered the whole area. On the flanks of the hill, both to the northwest, where the Los Angeles Terminal Railway cuts the ridge, and toward the south, where the ocean has exposed the beds, sands overlie or replace the gravel stratum. This fossiliferous upper San Pedro stratum is at no place on Los Cerritos Hill more than a few feet thick. W. S. T. Smith[1] thinks that perhaps this hill is wave built, but a careful examination shows that it is the result of an orogenic movement which has taken place since the lower San Pedro beds were deposited there. This is shown by the contortion of the lower formation, and by the steep dips of the uppermost layers, which conform almost exactly with the slope of the hill. This orogenic movement has taken place since the upper San Pedro series was deposited, and is evidence in favor of the theory that the upper San Pedro beds are at least older than the latest Pleistocene.

## List of Species Collected in the Upper San Pedro Beds at Los Cerritos.

### PELECYPODA.

*Aligena cerritensis*
*Amiantis callosa*
*Angulus buttoni*
*Anomia lampe*
*Astarte branneri*
*Cardium corbis*
*Cardium elatum*
*Cardium procerum*
*Cardium quadrigenarium*
*Chama exogyra*
*Chama pellucida*
*Corbula luteola*
*Cryptomya californica*
*Donax lævigata*
*Glycymeris barbarensis*
*Glycymeris septentrionalis*
*Hinnites giganteus*
*Lævicardium substriatum*

[1] Topographic Study of the Islands of Southern California. By W. S. T. Smith. Bull. Dept. Geol., Univ. of Cal., Vol. II, 1900, p. 224.

*Leda taphria*
*Lithophagus plumula*
*Lucina californica*
*Lucina nuttalli*
*Macoma indentata*
*Macoma inquinata*
*Macoma nasuta*
*Macoma* var. *kelseyi*
*Macoma secta*
*Mactra catilliformis*
*Mactra falcata*
*Metis alta*
*Modiola fornicata*
*Modiola recta*
*Nucula suprastriata*
*Ostrea lurida*
*Panopea generosa*
*Pecten latiauritus*
*Pecten* var. *fragilis*
*Pecten* var. *monotimeris*
*Pecten newsomi*
*Pecten ventricosus*
*Periploma argentaria*
*Petricola carditoides*
*Petricola denticulata*
*Pholadidea penita*
*Platyodon cancellatus*
*Psephis tantilla*
*Sanguinolaria nuttalli*
*Saxidomus aratus*
*Semele decisa*
*Semele pulchra*
*Siliqua lucida*
*Solen sicarius*
*Tagelus californianus*
*Tapes lacineata*
*Tapes staminea*
*Tapes tenerrima*
*Tellina bodegensis*
*Tellina idæ*
*Tivela crassatelloides*
*Tresus nuttalli*
*Venus neglecta*
*Venus simillima*
*Venus succincta*
*Zirphœa gabbi*

GASTROPODA.

*Acmæa insessa*
*Acmæa pelta*
*Amphissa corrugata*
*Amphissa versicolor*
*Bittium quadrifilatum*
*Bittium rugatum*
*Bulla punctulata*
*Cœcum californicum*
*Cœcum crebricinctum*
*Calliostoma canaliculatum*
*Calliostoma costatum*
*Calliostoma gemmulatum*
*Calliostoma tricolor*
*Cerithidea californica*
*Chlorostoma funebrale*
*Chlorostoma* var. *subapertum*
*Chlorostoma* var. *ligulatum*
*Chorus belcheri*
*Clipidella bimaculata*
*Clipidella callomarginata*
*Columbella gausapata*
*Columbella* var. *carinata*
*Columbella tuberosa*
*Conus californicus*
*Crepidula adunca*
*Crepidula dorsata*
*Crepidula navicelloides*
*Crepidula onyx*
*Crepidula rugosa*
*Crucibulum spinosum*
*Drillia cancellata*
*Drillia hemphilli*
*Drillia inermis*
*Drillia* var. *penicillata*
*Drillia torosa*
*Eulima micans*
*Fissuridea aspera*
*Fissuridea inœqualis*
*Fissuridea murina*
*Fissurella volcano*
*Fusus luteopictus*
*Hipponyx cranioides*
*Lacuna compacta*
*Lacuna porrecta*
*Leptothyra bacula*
*Littorina scutulata*
*Lucapina crenulata*
*Mangilia angulata*
*Mangilia interlirata*
*Mangilia striosa*
*Margarita* var. *pedroana*
*Melampus olivaceus*
*Monoceros engonatum*
*Murex festivus*
*Nassa californiana*
*Nassa cerritensis*
*Nassa fossata*
*Nassa mendica*
*Nassa* var. *cooperi*
*Nassa perpinguis*
*Nassa tegula*
*Natica lewisii*
*Neverita recluziana*
*Ocinebra* var. *aspera*
*Ocinebra* var. *cerritensis*
*Ocinebra poulsoni*
*Olivella biplicata*
*Olivella intorta*
*Olivella pedroana*
*Pleurotoma perversa*
*Ranella californica*
*Scala hindsii*
*Scala indianorum*
*Scala tincta*
*Serpulorbis squamigerus*
*Sigaretus debilis*
*Siphonalia kellettii*
*Spiroglyphus lituella*
*Taranis strongi*
*Terebra simplex*
*Tornatina culcitella*
*Trophon cerritensis*
*Turbonilla aurantia*
*Turbonilla crebrifilata*
*Turbonilla laminata*
*Turbonilla lowei*
*Turbonilla similis*
*Turbonilla stearnsii*
*Turbonilla subcuspidata*
*Turbonilla tenuicula*
*Turbonilla tridenta*
*Turritella cooperi*
*Volvaria varia*

CRUSTACEA.

*Balanus concavus*

SCAPHOPODA.

*Dentalium hexagonum*

ECHINOIDEA.

*Echinarachnius excentricus*

This fauna consists of one hundred and sixty species, of which sixty-four are pelecypods, ninety-two are gastropods, one is a scaphopod, one is a crustacean, and

one is an echinoderm. It is similar to the upper San Pedro fauna of the beds at the north end of the San Pedro bluff; and has even a more southern character than that fauna. The great preponderance of pelecypods over gastropods as regards the number of individuals is noteworthy in the Los Cerritos deposits. It is such a fauna as would be found on a low, sandy coast.

There is an extensive exposure of upper San Pedro strata in the bluff to the south and southeast of Long Beach. A typical section of the bluff is represented by the section exposed at *B* (diagram *E*, Plate XXIII), about one and one-half miles east of the Long Beach wharf. The sequence of the beds is as follows :

| | |
|---|---|
| Soil, grading into unstratified brown sand | 12 feet |
| Thin beds of light gray sand | 8 feet |
| White wind-bedded sand | 15 feet |
| Brown sand, with horizontal bedding | 6 feet |
| Total thickness | 41 feet |

All of the strata from this point west to *A* (diagram *E*, Plate XXIII), the end of the bluff, dip gently westward, the lower strata disappearing successively under the level of the beach. The fossils in this series occur only in local deposits, most of them being found in lens-shaped pockets in the white sand layer. There is a very fossiliferous deposit at *E*, which extends for three hundred feet along the base of the cliff. At *B* (diagram E, Plate XXIII), also, there is a small deposit of sand containing only *Ostrea lurida*. It is probable that for the most part these strata were deposited during a period of sand-dune and estuarine conditions along this part of the coast. The dominating shells in these deposits are *Ostrea lurida*, *Cryptomya californica*, *Tagelus californianus*, and other forms which inhabit lagoons and shallow waters. The following fossils were obtained from the fossiliferous bed at the base of the bluff at *E*, southeast of Long Beach.

List of Fossils from the Beds Southeast of Long Beach.

*Anomia lampe*
*Balanus concavus*
*Crepidula rugosa*
*Columbella* var. *carinata*
*Cardium procerum*
*Cardium quadrigenarium*
*Crucibulum spinosum*
*Chione simillima*
*Chlorostoma funebrale*
*Cryptomya californica*
*Conus californicus*
*Donax lævigata*
*Dentalium hexagonum*
*Drillia* var. *penicillata*
*Fissuridea inæqualis*
*Glycymeris septentrionalis*
*Lucina nuttalli*
*Lucina californica*
*Littorina scutulata*
*Lunatia lewisii*
*Leda taphria*
*Monoceros engonatum*
*Macoma secta*
*Macoma nasuta*
*Neverita reculziana*
*Nassa perpinguis*
*Nassa cerritensis*
*Nassa tegula*
*Nassa mendica*
*Nassa* var. *cooperi*
*Nassa fossata*
*Nassa californiana*
*Ostrea lurida*
*Olivella biplicata*
*Olivella pedroana*
*Olivella intorta*
*Pecten ventricosus*
*Pecten latiauritus*
*Pecten* var. *monotimeris*
*Pleurotoma carpenteriana*
*Pteronotus festivus*
*Serpulorbis squamigerus*
*Scala tincta*
*Terebra simplex*
*Tagelus californianus*
*Turritella cooperi*
*Tellina bodegensis*
*Tivela crassatelloides*
*Tapes staminea*
*Venericardia barbarensis*
*Zirphæa gabbi*

The deposits of Dominguez Hill are probably of upper San Pedro age, although no fossils have been found in them. Lithologically they are similar to the deposits around the base of Los Cerritos Hill.

*Raised Beach Formation.*—The recently raised beach on the north end of Deadman Island (see diagram *B*, Plate XXII) shows that the period of uplift which followed the deposition of the upper San Pedro beds is not yet finished. This raised beach contains many fossil shells in a perfect state of preservation, all of them retaining their original color, which suggests how recently this uplift has taken place.

LIST OF FOSSILS FROM THE RAISED BEACH, NORTH END OF DEADMAN ISLAND.

PELECYPODA.

| | | |
|---|---|---|
| *Cryptomya californica* | *Macoma nasuta* | *Pecten* var. *monotimeris* |
| *Donax lævigata* | *Macoma secta* | *Pecten ventricosus* |
| *Lævicardium substriatum* | *Mactra catilliformis* | *Petricola carditoides* |
| *Lucina californica* | *Mactra falcata* | *Tapes staminea* |
| *Lucina nuttalli* | *Mytilus edulis* | *Tellina bodegensis* |
| *Macoma inquinata* | *Pecten latiauritus* | |

GASTROPODA.

| | | |
|---|---|---|
| *Acmœa spectrum* | *Columbella gausapata* | *Fissurella volcano* |
| *Acmœa pelta* | *Columbella* var. *carinata* | *Nassa fossata* |
| *Bulla nebulosa* | *Conus californicus* | *Nassa* var. *cooperi* |
| *Calliostoma canaliculatum* | *Crepidula rugosa* | *Olivella biplicata* |
| *Cerithidea californica* | *Crecibulum spinosum* | *Olivella intorta* |
| *Chlorostoma funebrale* | *Drillia* var. *penicillata* | |

These species are all found living in the waters adjacent to Deadman Island at the present time, and the raised beach specimens are in nearly as good a state of preservation as the living shells.

## 5. POST-PLEISTOCENE DEPOSITS.

Overlying the Pleistocene of Deadman Island, and all along the San Pedro terrace, is soil containing many shells, in fact, in places it is made up almost entirely of shells. These are the remains of ancient Indian kitchen-middens. Ashley[1] describes as Quaternary a layer of shells found in the lower terrace of San Pedro Hill. After examining the fossils collected by him, and also visiting the locality from which they came, the writer is convinced that these deposits are simply the shells brought there by the Indians, for the association of species is not such as would be found at any one place on the beach; rocky shore and lagoon shells being found in about equal quantities. At every place where these shell deposits in the soil have been examined by the writer they have been found to contain pieces of charcoal, bones of mammals, and other evidences of refuse heaps. These kitchen-middens are common at many places along the coast. Those at Port Harford are over six feet in thickness and have been mistaken by some collectors for Pleistocene strata.

The shells in these kitchen waste heaps are of a kind that would be used for food, and include such species as *Haliotis cracheroidii, Pecten æquisulcatus, Chione succincta, Tivela crassatelloides, Tapes staminea, Saxidomus aratus*, etc. All of the specimens of *Haliotis* so far recorded from the Pleistocene, with the exception of one

[1] The Neocene Stratigraphy of the Santa Cruz Mountains of California. By George H. Ashley. Proc. Cal. Acad. Sci., 2d Ser., Vol. V, 1895, pp. 353-355.

*Haliotis fulgens* found by the writer in the upper San Pedro conglomerate of Deadman Island, and another in the Pleistocene at Spanish Bight, San Diego, have been taken from these Indian kitchen-middens.

## 6. Alphabetic List showing the Distribution of Species in the Vicinity of San Pedro.

In order to avoid any mistake, a brief description of the locality represented by each column in the following list is here given.

The second column, marked "Deadman Island" under upper San Pedro series, refers to the gravel stratum which extends across Deadman Island about six feet below the surface, and which is shown as the upper San Pedro series in diagram *B*, Pl. XXII. (See also diagram *E*, Pl. XXIII.)

The third column, marked "Lumber Yard," refers to the sand and gravel deposits at the north end of the San Pedro bluff; these beds are designated as upper San Pedro series in diagram *D*, Pl. XXII.

The fourth column refers to Los Cerritos Hill, which is shown on diagram *E*, Pl. XXIII, and diagram *C*, Pl. XXII. The fossils reported in this column come from the gravel and sand strata at the localities *H* and *K* on that hill.

The fifth column, designated as "Crawfish George's," refers to the deposits on the northeast side of the mouth of the ravine which empties into the ocean at Crawfish George's. (See diagram *E*, Pl. XXIII.)

The sixth column, marked "Deadman Island" under lower San Pedro series, refers to the gray sand deposits lying between the Pliocene and upper San Pedro gravel strata; this deposit is designated as lower San Pedro series in diagram *B*, Pl. XXII.

The seventh column, designated as "San Pedro Bluffs," refers to the lower San Pedro strata which lie above the Pliocene on the south and below the upper San Pedro series on the north, in the water front bluff east of San Pedro; these deposits are designated as lower San Pedro series in diagram *D*, Pl. XXII.

Column eight, marked "Deadman Island" under Pliocene, refers to the brown sand, "Cryptodon beds," and contact stratum of Deadman Island; these deposits are designated as Pliocene in diagram *B*, Pl. XXII.

The ninth column, marked "Timm's Point" under Pliocene, refers to the brown sand deposits of Timm's Point and between that point and the middle of the railroad cut and grade up the bluff in the southeastern portion of San Pedro; these deposits are designated as Pliocene in diagram *D*, Pl. XXII.

## Alphabetic List Showing the Distribution of Species in the Vicinity of San Pedro.*

(E indicates species which are extinct; X indicates species living at San Pedro; S indicates species living only south of San Pedro; N indicates species living only north of San Pedro; C indicates species living only at Catalina Island; R stands for rare; M stands for medium abundant; C stands for common.)

| | Living. | Pleistocene. | | | | | | Pliocene. | |
|---|---|---|---|---|---|---|---|---|---|
| | | Upper San Pedro. | | | | Lower San Pedro. | | | |
| | San Pedro. | Deadman Island. | Lumber Yard. | Los Cerritos. | Crawfish George's. | Deadman Island. | San Pedro Bluffs. | Deadman Island. | Timm's Point. |
| PELECYPODA. | | | | | | | | | |
| *Aligena cerritensis*, sp. nov. | E | | | R | | | | | |
| *Amiantis callosa* Conrad | X | | R | C | | | | | |
| *Angulus buttoni* Dall | X | R | R | R | R | M | R | | |
| *Anomia lampe* Gray | X | | C | C | M | R | R | | |
| *Arca labiata* Sowerby | S | | R | | | | | | |
| *Astarte (Crassinella) branneri*, sp. nov. | E | | M | M | | | | | |
| *Bornia retifera* Dall | N | | | | | R | | | |
| *Callista subdiaphana* Carpenter | N | | | | | | | C | C |
| *Callista subdiaphana* var. *pedroana*, var. nov. | E | | | | | R | | | |
| *Callista newcombiana* Gabb | X | R | R | | | | | | |
| *Cardium corbis* Martyn | N | R | M | M | M | M | M | | |
| *Cardium elatum* Sowerby | S | | R | R | | | | | |
| *Cardium procerum* Sowerby | S | | C | C | | R | | | |
| *Cardium quadrigenarium* Conrad | X | | C | C | | | | | |
| *Chama exogyra* Conrad | X | | R | R | | | | | |
| *Chama pellucida* Sowerby | X | R | R | R | R | M | | C | |
| *Clidiophora punctata* Conrad | X | | R | | | R | | | |
| *Cooperella subdiaphana* Carpenter | X | | | | | R | | | |
| *Corbula luteola* Carpenter | X | | R | M | | R | M | R | |
| *Cryptomya californica* Conrad | X | R | C | M | R | M | M | | |
| *Cumingia californica* Conrad | X | R | R | | R | R | C | R | |
| *Diplodonta orbella* Gould | X | | R | | R | R | | | |
| *Diplodonta serricata* Reeve | S | | C | | | | | | |
| *Donax californica* Conrad | X | | R | | | R | R | | |
| *Donax lævigata* Deshayes | X | M | C | C | M | R | M | | |
| *Glycymeris barbarensis* Conrad | E | R | C | R | R | | | | |

* This list has been kept open until the time for sending the manuscript to press, and contains a few species which are not given in the general discussion, although the descriptions of all species mentioned are given in Part II.

| | Living. | Pleistocene. | | | | | | Pliocene. | |
|---|---|---|---|---|---|---|---|---|---|
| | | Upper San Pedro. | | | | Lower San Pedro. | | | |
| | San Pedro. | Deadman Island. | Lumber Yard. | Los Cerritos. | Crawfish George's. | Deadman Island. | San Pedro Bluffs. | Deadman Island. | Timm's Point. |
| *Glycymeris septentrionalis* Middendorf | N | R | C | R | R | | | | |
| *Hinnites giganteus* Gray | X | R | M | R | R | | R | | |
| *Kellia laperousii* Deshayes | X | | | | | R | R | R | |
| *Kellia suborbicularis* Montague | X | | | | | R | R | | |
| *Kennerlia bicarinata* Carpenter | C | | | | | R | | | |
| *Kennerlia filosa* Carpenter | N | | | | | R | | | |
| *Lævicardium substriatum* Conrad | X | R | C | R | R | R | R | | |
| *Lazaria subquadrata* Carpenter | X | | C | | R | R | R | | |
| *Leda fossa* Baird | N | | | | | M | | | |
| *Leda hamata* Carpenter | X | | | | | R | | | |
| *Leda minuta* var. *præcursor*, var. nov. | N | | | | | R | R | | |
| *Leda taphria* Dall | X | R | M | M | R | C | R | C | R |
| *Lima dehiscens* Conrad | X | | | | | R | | | |
| *Lithophagus plumula* Hanley | X | | | R | | | | | |
| *Lucina acutilineata* Conrad | X | R | R | | R | C | C | C | C |
| *Lucina californica* Conrad | X | R | R | R | R | C | C | C | |
| *Lucina nuttalli* Conrad | X | C | C | C | M | C | C | | |
| *Lucina tenuisculpta* Carpenter | X | | R | | | | | | |
| *Lyonsia californica* Conrad | X | R | R | | R | M | C | C | |
| *Macoma calcarea* Gmelin | N | | | | | M | | M | |
| *Macoma indentata* Carpenter | X | | R | R | | | | | |
| *Macoma inquinata* Deshayes | X | R | C | C | R | M | C | C | |
| *Macoma nasuta* Conrad | X | M | C | M | M | C | | | |
| *Macoma nasuta* var. *kelseyi* Dall | S | | M | M | | | M | | |
| *Macoma secta* Conrad | X | R | C | R | R | R | R | | |
| *Macoma yoldiformis* Carpenter | X | | | | R | R | | | |
| *Mactra californica* Conrad | X | | M | | | | | | |
| *Mactra* (*Spisula*) *catilliformis* Conrad | X | C | C | C | R | | | | |
| *Mactra exoleta* Gray | S | | R | | | | | | |
| *Mactra* (*Spisula*) *falcata* Gould | X | M | C | C | M | R | R | | |
| *Mactra hemphilli* Dall | S | | R | | | | | | |
| *Metis alta* Conrad | X | R | R | C | R | R | | | |
| *Modiola fornicata* Carpenter | N | | | R | | R | | | |
| *Modiola recta* Conrad | X | R | R | R | | R | | | |
| *Mœrella salmonea* Carpenter | N | | | | | C | | | |
| *Mytilus edulis* Linnæus | X | R | R | | R | R | | | |

| | Living. | Pleistocene. | | | | | | Pliocene. | |
|---|---|---|---|---|---|---|---|---|---|
| | | Upper San Pedro. | | | | Lower San Pedro. | | | |
| | San Pedro. | Deadman Island. | Lumber Yard. | Los Cerritos. | Crawfish George's. | Deadman Island. | San Pedro Bluffs. | Deadman Island. | Timm's Point. |
| *Mytilimeria nuttalli* Conrad | X | | | | | R | R | R | |
| *Neæra pectinata* Carpenter | X | | | | | R | | | |
| *Nucula (Acila) castrensis* Hinds. | X | | | | | R | R | C | R |
| *Nucula suprastriata* Carpenter | N | | C | C | | R | R | | |
| *Ostrea lurida* Carpenter | X | | C | R | R | R | R | | |
| *Panomya ampla* Dall | N | | | | | R | | R | |
| *Panopea generosa* Gould | X | R | | R | | R | | R | |
| *Pecten (Patinopecten) caurinus* Gould | N | | R | | R | M | | C | C |
| *Pecten (Pecten) dentatus* Sowerby | S | | | | | | | | |
| *Pecten (Chlamys) hastatus* Sowerby | X | | | | R | R | | M | |
| *Pecten (Chlamys) hericeus* Gould | N | | | | | R | | M | |
| *Pecten (Chlamys) hericeus* var. *strategus* Dall | N | | | | | R | | | |
| *Pecten (Chlamys) jordani*, sp. nov | E | | | | | R | | M | |
| *Pecten latiauritus* Conrad | X | M | C | C | R | R | R | | |
| *Pecten latiauritus* var. *fragilis*, var. nov | E | | R | R | | | | | |
| *Pecten latiauritus* var. *monotimeris* Conrad | X | R | R | M | R | R | R | | |
| *Pecten (Plagioctenium) newsomi*, sp. nov | E | | R | R | | | | | |
| *Pecten stearnsii* Dall | E | | | | | | | R | |
| *Pecten (Nodipecten) subnodosus* Sowerby | S | R | R | | | | | | |
| *Pecten (Plagioctenium) ventricosus* Sowerby | X | M | C | M | R | | | | |
| *Pecten (Plagioctenium) ventricosus* Sowerby var. | E | | R | | | | | | |
| *Periploma argentaria* Conrad | X | R | R | R | R | | | | |
| *Petricola carditoides* Conrad | X | M | M | R | M | R | | | |
| *Petricola (Petricolaria) cognata* C. B. Adams | X | R | R | | | | | | |
| *Petricola denticulata* Sowerby | S | | R | C | | R | | | |
| *Pholadidea penita* Conrad | X | M | M | M | M | | | R | |
| *Platyodon cancellatus* Conrad | X | R | R | R | R | | | | |
| *Pododesmus (Monia) macroschisma* Deshayes | X | R | R | | R | | | | |
| *Protocardia centifilosa* Carpenter | X | | | | | R | | C | R |
| *Psammobia edentula* Gabb | ? | | R | | | | | | |
| *Psephis salmonea* Carpenter | C | | | | | R | R | | |
| *Psephis tantilla* Gould | N | R | R | R | | M | R | | |
| *Rœta undulata* Gould | X | | | | | R | | | |
| *Rupellaria lamellifera* Conrad | X | R | | | | | | | |
| *Sanguinolaria nuttalli* Conrad | X | | M | R | | | | | |
| *Saxidomus aratus* Gould | X | C | C | C | R | R | | | |

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| *Semele decisa* Conrad | X | M | M | C | | | M | | |
| *Semele pulchra* Sowerby | X | | R | R | | | | | |
| *Semele pulchra* var. *montereyi*, var. nov | N | | | | | R | | | |
| *Septifer bifurcatus* Conrad | X | | | | | R | | | |
| *Siliqua lucida* Conrad | X | | M | M | | R | M | | |
| *Siliqua patula* var. *nuttalli* Conrad | N | | R | | | | | | |
| *Solen rosaceus* Carpenter | X | R | | | R | R | R | | |
| *Solen sicarius* Gould | X | R | R | R | R | C | M | C | M |
| *Tagelus californianus* Conrad | X | C | C | C | M | | | | |
| *Tapes laciniata* Carpenter | X | | R | M | | | | | |
| *Tapes staminea* Conrad | X | C | C | C | M | R | M | | |
| *Tapes tenerrima* Carpenter | X | R | R | R | R | | | | |
| *Tellina bodegensis* Hinds | X | R | C | C | R | M | M | | |
| *Tellina idæ* Dall | X | | | R | | | | | |
| *Tellina rubescens* Hanley | S | | R | | | | | | |
| *Thracia trapezoides* Conrad | E | | | | | | | R | C |
| *Thyasira bisecta* Conrad | N | | | | | | | C | R |
| *Thyasira gouldii* Philippi | X | | | | | | | R | R |
| *Tivela crassatelloides* Conrad | X | R | C | M | R | R | | | |
| *Tresus nuttalli* Conrad | X | C | C | R | R | | | | |
| *Venericardia barbarensis* Stearns | X | | R | | R | R | | C | M |
| *Venericardia ventricosa* Gould | N | | | | | R | | C | C |
| *Venus (Chione) fluctifraga* Sowerby | X | | R | | | | | | |
| *Venus (Chione) gnidia* Broderip & Sowerby | S | | R | | | | | | |
| *Venus (Chione) neglecta* Sowerby | S | | R | R | | | | | |
| *Venus (Chione) simillima* Sowerby | X | M | C | C | R | R | | R | |
| *Venus (Chione) succincta* Valenciennes | X | C | C | C | C | | | | |
| *Verticordia novemcostata* Adams & Reeve | X | | | | | R | | | |
| *Yoldia cooperi* Gabb | X | | R | | | | | | |
| *Yoldia scissurata* Dall | X | | | | | R | | | |
| *Zirphæa gabbi* Tryon | X | R | M | R | M | | | | |

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| **GASTROPODA.** | | | | | | | | | |
| *Acmæa depicta* Gould | S | | | | R | | | | |
| *Acmæa insessa* Hinds | X | R | M | R | M | M | M | M | |
| *Acmæa instabilis* Gould | N | | | | R | | | | |
| *Acmæa mitra* Eschscholtz | X | | | | C | | | | |
| *Acmæa paleacea* Gould | X | | | | C | | | | |
| *Acmæa pelta* Eschscholtz | X | | R | M | | R | | | |
| *Acmæa spectrum* (Nuttall) Reeve | X | R | M | | | R | | | |
| *Actæon (Rictaxis) punctocælata* Carpenter | X | | R | | | R | R | | |
| *Actæon traskii* Stearns | ? | | R | | | | | | |
| *Admete gracilior* Carpenter | E | | | | | R | | | |
| *Amphissa corrugata* Reeve | X | | R | R | R | R | | C | |
| *Amphissa ventricosa*, sp. nov | E | | | | | R | | | |
| *Amphissa versicolor* Dall | X | R | R | R | C | R | | | |
| *Bela fidicula* Gould | N | | | | R | R | | R | |
| *Bela sanctæ-monicæ* sp. nov | E | | | | | R | | | |
| *Bittium asperum* Gabb | X | | R | | R | M | | C | R |
| *Bittium californicum* Dall & Bartsch | E | | | | | R | | | |
| *Bittium filosum* Gould | N | | C | | R | M | M | | |
| *Bittium quadrifilatum* Carpenter | X | R | R | R | M | M | M | | |
| *Bittium rugatum* Carpenter | X | | C | C | C | C | C | | |
| *Bittium williamsoni*, sp. nov | ? | | R | | | | | | |
| *Bulla punctulata* A. Adams | S | R | C | C | M | | | | |
| *Bulla quoyi* Gray | X | | R | | | | | | |
| *Cæcum californicum* Dall | X | | R | R | | C | M | | |
| *Cæcum crebricinctum* Carpenter | X | | R | R | R | R | C | | |
| *Cæcum magnum* Stearns | ? | | | | | R | R | | |
| *Calliostoma annulatum* Martyn | X | | M | | | | | | |
| *Calliostoma caniculatum* Martyn | X | R | M | C | C | M | M | R | |
| *Calliostoma costatum* Martyn | X | | M | R | R | R | R | | |
| *Calliostoma gemmulatum* Carpenter | X | | M | R | R | | | | |
| *Calliostoma tricolor* Gabb | X | | M | R | R | | C | R | |
| *Cancellaria cooperi* Gabb | X | | R | | | | | | |
| *Cancellaria crawfordiana* Dall | S | | R | | | | | | |
| *Cancellaria tritonidea* Gabb | E | | R | | | | | | |

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| *Cerithidea californica* Haldemann | X | R | C | R | | R | M | R | |
| *Chlorostoma aureotinctum* Forbes | X | | M | | | | | | |
| *Chlorostoma brunneum* Philippi | X | R | | | R | | | R | |
| *Chlorostoma funebrale* A. Adams | X | R | M | R | C | R | R | | |
| *Chlorostoma funebrale* var. *subapertum* Carpenter | X | R | M | R | C | R | R | | |
| *Chlorostoma gallina* Forbes | X | R | R | | R | | | | |
| *Chlorostoma montereyi* Kiener | X | R | R | | R | R | | R | |
| *Chlorostoma (Omphalius) viridulum* var. *ligulatum* Menke | X | R | M | C | C | R | M | | |
| *Chorus belcheri* Hinds | X | | M | R | R | | | | |
| *Chrysodomus*, sp. indet. | N | | | | | | | R | |
| *Chrysodomus rectirostris* Carpenter | N | | | | R | M | | M | |
| *Chrysodomus tabulatus* Baird | X | | | | | M | R | C | R |
| *Clathurella conradiana* Gabb | ? | | R | | | C | R | C | |
| *Clypidella bimaculata* Dall | N | | R | R | | M | M | | |
| *Clypidella callomarginata* Carpenter | X | | R | R | R | R | R | | |
| *Columbella (Astyris) californiana* Gaskoin | X | | | | | R | M | | |
| *Columbella (Æsopus) chrysalloidea* Carpenter | X | | C | | | R | R | | |
| *Columbella (Astyris) gausapata* Gould | X | R | R | R | R | R | R | R | R |
| *Columbella (Astyris) gausapata* var. *carinata* Hinds | X | C | C | C | M | M | M | C | M |
| *Columbella (Anachis) minima*, sp. nov. | E | | R | | | | | | |
| *Columbella (Æsopus) oldroydi*, sp. nov. | E | | | | | R | | | |
| *Columbella solidula* var. *præcursor*, var. nov. | S | | R | | | | | | |
| *Columbella (Astyris) tuberosa* Carpenter | X | R | C | R | R | M | R | | |
| *Conus californicus* Hinds | X | C | C | C | C | M | M | M | M |
| *Coralliophila nux* Reeve | S | | R | | | | | | |
| *Crepidula aculeata* Gmelin | X | | | | | R | M | | |
| *Crepidula adunca* Sowerby | X | M | C | M | M | M | M | | |
| *Crepidula dorsata* Broderip | X | | | R | R | R | | | |
| *Crepidula grandis* Middendore | N | R | | | | | | | |
| *Crepidula navicelloides* Nuttall | X | M | C | R | M | R | M | | |
| *Crepidula onyx* Sowerby | S | R | M | R | | R | M | | |
| *Crepidula rugosa* Nuttall | X | C | C | C | C | R | | | |
| *Crucibulum spinosum* Sowerby | X | M | C | M | M | | C | | |
| *Cryptochiton stelleri* Middendorf | N | | | | | R | | R | |

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| *Cylichna alba* Brown | X | | R | | | M | | | |
| *Cypræa spadicea* Gray | X | R | R | | | | | | |
| *Cythara branneri*, sp. nov | E | | | | | C | | | |
| *Diastoma*, sp. indet | ? | | | | | R | | | |
| *Drillia cancellata* Carpenter | N | | | R | | M | | | |
| *Drillia hemphilli* Stearns | S | | C | M | R | M | R | | |
| *Drillia inermis* Hinds | X | | C | C | | R | | | |
| *Drillia inermis* var. *penicillata* Carpenter | X | M | C | C | M | R | M | | |
| *Drillia johnsoni*, sp. nov | E | | R | | | | | | |
| *Drillia merriami*, sp. nov | E | | | | | R | | R | |
| *Drillia montereyensis* Stearns | N | | | | | R | | | |
| *Drillia pudica* Hinds | S | | R | | | | | | |
| *Drillia torosa* Carpenter | X | R | R | R | C | R | R | C | M |
| *Erato columbella* Menke | X | | R | | | | | | |
| *Eulima falcata* Carpenter | S | | | | | R | | | |
| *Eulima hastata* Sowerby | S | | R | | | R | | | |
| *Eulima micans* Carpenter | X | | R | M | R | C | M | | |
| *Eupleura muriciformis* Broderip | S | R | R | | | R | | | |
| *Eupleura muriciformis* var. *curta*, var. nov | E | | R | | | | | | |
| *Fissuridea aspera* Eschscholtz | X | R | R | R | C | R | M | | |
| *Fissuridea inæqualis* Sowerby | S | R | R | M | | | | | |
| *Fissuridea murina* (Carpenter) Dall | X | R | R | R | M | R | | | |
| *Fissurella volcano* Reeve | X | M | C | M | C | M | M | | |
| *Fusus barbarensis* Trask | X | R | R | | R | R | | C | M |
| *Fusus luteopictus* Dall | X | M | M | M | C | R | | | |
| *Fusus robustus* Trask | X | R | R | | C | | | | |
| *Fusus rugosus* Trask | X | | | | | M | | | |
| *Gadinia reticulata* Sowerby | X | | R | | | | | | |
| *Galerus mammillaris* Broderip | X | | R | | R | R | R | | |
| *Haliotis fulgens* Philippi | X | R | | | | | | | |
| *Haminea virescens* Sowerby | X | | R | | | | | | |
| *Helix* (*Epiphragmophora*), sp. indet | ? | | R | | | | | | |
| *Hipponyx antiquatus* Linnæus | X | | | | | R | | R | |
| *Hipponyx cranioides* Carpenter | N | R | | R | | C | M | | |
| *Hipponyx tumens* Carpenter | X | R | | | | R | R | | |

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| *Isapis fenestrata* Carpenter | X | R | M | | R | R | C | | |
| *Ischnochiton regularis* Carpenter | X | | R | | | | | | |
| *Ivara terricula* (Carpenter) Dall & Bartsch | S | | | | | R | | | |
| *Lacuna compacta* Carpenter | N | | M | R | | R | | | |
| *Lacuna porrecta* Carpenter | N | R | C | R | R | M | M | | |
| *Lacuna solidula* (Loven) Carpenter | X | | R | | | R | | | |
| *Lamellaria stearnsii* Dall | X | | | | | R | | | |
| *Leptothyra bacula* Carpenter | X | | | R | | R | | | |
| *Leptothyra carpenteri* Pilsbry | X | | R | | R | R | R | | |
| *Leptothyra paucicostata* Dall | X | | | | | R | | | |
| *Littorina planaxis* (Nuttall) Philippi | X | | R | | | R | R | R | |
| *Littorina scutulata* Gould | X | R | M | R | R | M | C | | |
| *Lucapina crenulata* Sowerby | X | | | R | | | | | |
| *Macron kellettii* A. Adams | S | | R | | | | | | |
| *Macron lividus* A. Adams | X | | R | | | | | | |
| *Mangilia angulata* Carpenter | N | | | R | R | C | M | | |
| *Mangilia hooveri*, sp. nov | E | | R | | | | | | |
| *Mangilia interfossa* var. *pedroana*, var. nov | E | | | | R | R | | | |
| *Mangilia interlirata* Stearns | X | | | R | | R | | | |
| *Mangilia oldroydi*, sp. nov | E | | | | | R | | | |
| *Mangilia painei*, sp. nov | E | | | | | R | | | |
| *Mangilia sculpturata* Dall | X | | | | | C | | R | |
| *Mangilia striosa* C. B. Adams | X | | R | R | | | | | |
| *Margarita obtabilis* var. *knechti*, var. nov | E | | R | | | | C | | |
| *Margarita optabilis* var. *nodosus*, var. nov | E | | | | | R | R | | |
| *Margarita parcipicta* var. *pedroana*, var. nov | E | R | M | R | | R | C | | |
| *Margarita pupilla* Gould | N | | | | | | | R | |
| *Marginella jewettii* Carpenter | X | R | R | | R | R | M | | |
| *Melampus olivaceus* Carpenter | X | R | C | R | R | R | M | | |
| *Mitra maura* Swainson | X | R | R | | M | | M | | |
| *Mitramorpha filosa* Carpenter | X | | | | | M | | | |
| *Mitramorpha intermedia*, sp. nov | E | | | | | M | | | |
| *Monoceros engonatum* Conrad | X | M | C | R | M | R | R | | |
| *Monoceros lapilloides* Conrad | X | | R | | | | | | |
| *Mopalia ciliata* Sowerby | X | | R | | | | | | |

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| *Murex (Pteronotus) festivus* Hinds | X | R | C | M | R | R | | | |
| *Murex (Pterohytis) foliatus* Martyn | N | | R | | | | | | |
| *Murex (Pterohytis) nuttalli* Conrad | X | R | | R | R | | | | |
| *Murex (Chicoreus) leeanus* Dall | S | | C | | M | | | | |
| *Murex (Cerostoma) monoceros* Sowerby | S | | C | | | | | | |
| *Murex trialatus* Sowerby | X | R | M | | R | | | | |
| *Nassa californiana* Conrad | X | R | C | R | | R | | R | |
| *Nassa cerritensis*, sp. nov | E | | R | C | R | | | | |
| *Nassa fossata* Gould | X | M | M | M | C | R | R | R | |
| *Nassa insculpta* Carpenter | C | | R | | | | | | |
| *Nassa mendica* Gould | X | M | C | R | M | C | M | M | M |
| *Nassa mendica* var. *cooperi* Forbes | X | C | C | C | C | C | C | M | M |
| *Nassa perpinguis* Hinds | X | M | C | C | M | C | C | R | R |
| *Nassa tegula* Reeve | X | R | M | R | R | R | R | | |
| *Nassa versicolor* var. *hooveri*, var. nov | S | | R | | | | | | |
| *Natica clausa* Broderip & Sowerby | N | | | | | R | | M | R |
| *Natica (Lunatia) lewisii* Gould | X | M | C | M | R | | | | |
| *Neverita recluziana* Petit | X | M | C | C | M | R | R | R | |
| *Norrisia norrisii* Sowerby | X | R | | | | | | | |
| *Ocinebra barbarensis* Gabb | X | | | | | R | R | | |
| *Ocinebra foveolata* Hinds | X | | R | | | | | | |
| *Ocinebra interfossa* Carpenter | X | R | M | | R | R | R | R | |
| *Ocinebra keepi*, sp. nov | E | R | R | | | | | | |
| *Ocinebra lurida* Middendorf | X | | | | R | | | | |
| *Ocinebra lurida* var. *aspera* Baird | N | R | C | R | R | R | R | | |
| *Ocinebra lurida* var. *cancellina* Philippi | S | | R | | | | | | |
| *Ocinebra lurida* var. *cerritensis*, var. nov | E | | | R | R | R | R | | |
| *Ocinebra lurida* var. *munda* Carpenter | C | | | | | R | | | |
| *Ocinebra micheli* Ford | ? | | | | R | | | | |
| *Ocinebra perita* Hinds | X | M | C | | M | M | | | |
| *Ocinebra poulsoni* Nuttall | X | R | M | M | R | R | M | | |
| *Odostomia gouldii* Carpenter | X | | | | | R | R | | |
| *Odostomia nuciformis* var. *avellana* Carpenter | N | | | | | R | | | |
| *Odostomia tenuis* Carpenter | X | | R | | | | R | | |
| *Olivella biplicata* Sowerby | X | C | C | M | C | C | C | R | R |

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| *Olivella intorta* Carpenter | X | C | C | R | M | C | C | M | |
| *Olivella pedroana* Conrad | X | R | R | C | R | M | M | M | |
| *Opalia borealis* Gould | X | | R | | | | | | |
| *Opalia crenitoides* var. *insculpta* Carpenter | X | R | | | | | | | |
| *Pachypoma inæquale* Martyn | X | | R | | R | | R | | |
| *Paludestrina curta*, sp. nov. | E | | R | | | | R | | |
| *Paludestrina stokesi*, sp. nov. | E | | R | | | | R | | |
| *Phasianella compta* Gould | X | | C | | | R | R | | |
| *Phorcus pulligo* Martyn | X | | | | C | | | | |
| *Physa heterostropha* Say | X | | | | | | R | | |
| *Pisania fortis* Carpenter | E | R | R | | | | | | |
| *Planorbis tumidus* Pfeiffer | S | | M | | | | R | | |
| *Planorbis vermicularis* Gould | N | | M | | | | R | | |
| *Pleurotoma* (*Borsonia*) *bartschi*, sp. nov | E | | | | | M | | M | |
| *Pleurotoma* (*Dolichotoma*) *carpenteriana* Gabb | X | M | M | | R | | | | |
| *Pleurotoma* (*Dolichotoma*) *cooperi*, sp. nov | E | | R | | | | | | |
| *Pleurotoma* (*Borsonia*) *dalli*, sp. nov | E | | | | | R | | R | |
| *Pleurotoma* (*Borsonia*) *hooveri*, sp. nov. | E | | | | | R | | | |
| *Pleurotoma* (*Leucosyrinx*) *pedroana*, sp. nov. | E | | | | | R | | | |
| *Pleurotoma perversa* Gabb | X | M | R | R | C | R | R | M | |
| *Pleurotoma* (*Drillia*) *renaudi*, sp. nov. | E | | | | | R | | R | |
| *Pleurotoma* (*Spirotropsis*) *smithi*, sp. nov | E | | | | | M | | M | |
| *Pleurotoma* (*Dolichotoma*) *tryoniana* Gabb | X | | R | | | | | | |
| *Pomaulax undosus* Wood | X | | R | | R | | | | |
| *Priene oregonensis* Redfield | X | R | R | | M | R | | C | |
| *Puncturella cucullata* Gould | N | | R | | | R | | M | |
| *Puncturella galeata* Gould | N | | | | | R | | M | |
| *Purpura crispata* Chemnitz | N | R | R | | C | | | | |
| *Purpura saxicola* Valenciennes | X | | R | | | | | | |
| *Pyramidella conica* var. *variegata* Carpenter | S | | R | | | | | | |
| *Ranella californica* Hinds | X | R | C | R | R | | | | |
| *Rissoa acutelirata* Carpenter | S | | R | | | | | | |
| *Scala bellastriata* Carpenter | X | | R | | | | | | |
| *Scala crebricostata* Carpenter | X | R | M | | | | R | | |
| *Scala hemphilli* Dall | E | | R | | | | | | |

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| *Scala hindsii* Carpenter | X | R | C | R | M | R | M | | |
| *Scala indianorum* Carpenter | X | R | C | R | M | R | R | R | |
| *Scala tincta* Carpenter | X | R | R | R | R | R | R | | |
| *Seila assimilata* C. B. Adams | X | | | | | R | | | |
| *Serpulorbis squamigerus* Carpenter | X | M | M | R | R | R | R | | |
| *Sigaretus debilis* Gould | X | | R | R | | | | | |
| *Siphonalia kellettii* Forbes | X | | R | R | R | | | | |
| *Solariella cidaris* A. Adams | X | | | | | | | R | |
| *Solariella peramabilis* Carpenter | C | | | | | | | R | |
| *Spiroglyphus lituella* Morch | X | C | C | C | C | | | | |
| *Styliferina tenuisculpta* Carpenter | ? | | | | | R | | | |
| *Taranis strongi* sp. nov. | E | | | R | | R | R | R | |
| *Terebra (Acus) simplex* Carpenter | X | R | C | M | M | M | M | R | R |
| *Thalotia caffea* Gabb | X | | | | | R | | M | |
| *Tornatina cerealis* Gould | X | | M | | | R | M | | |
| *Tornatina culcitella* Gould | X | R | R | R | R | M | M | | |
| *Tornatina eximia* Baird | X | | | | | | | R | |
| *Tornatina harpa* Dall | X | R | R | | | R | R | | |
| *Triforis adversa* Montague | N | | | | | R | | | |
| *Trivia californica* Gray | X | | R | | | | | | |
| *Trivia solandri* Gray | X | | | | | R | | | |
| *Tritonium gibbosus* Broderip | S | | R | | | | | | |
| *Trophon (Boreotrophon) cerritensis*, sp. nov. | E | | | R | | R | | | |
| *Trophon (Boreotrophon) gracilis* Perry | X | | | | | R | | R | |
| *Trophon (Boreotrophon) multicostatus* Eschscholtz | N | | R | | | R | | | |
| *Trophon (Boreotrophon) pedroanus*, sp. nov. | E | | | | R | C | C | | |
| *Trophon (Boreotrophon) scalariformis* Gould | N | | | | R | C | | R | |
| *Trophon stuarti* Smith | N | | | | | R | | C | R |
| *Trophon orpheus* var. *præcursor*, var. nov. | E | | | | | M | | C | |
| *Trophon (Boreotrophon) tenuisculpta* Carpenter | E | | | | | | | R | |
| *Trophon (Boreotrophon) triangulatus* Carpenter | X | | | | | R | | | |
| *Turbonilla adleri* (Dall & Bartsch), sp. nov. | E | | | | | R | | | |
| *Turbonilla arnoldi* (Dall & Bartsch), sp. nov. | E | | | | | R | | | |
| *Turbonilla aurantia* Carpenter | X | | R | R | | R | R | | |
| *Turbonilla crebrifilata* Carpenter | X | | | R | | R | R | | |

| | Living. | Pleistocene. | | | | | | Pliocene. | |
|---|---|---|---|---|---|---|---|---|---|
| | | Upper San Pedro. | | | | Lower San Pedro. | | | |
| | San Pedro. | Deadman Island. | Lumber Yard. | Los Cerritos. | Crawfish George's. | Deadman Island. | San Pedro Bluffs. | Deadman Island. | Timm's Point. |
| *Turbonilla gibbosa* CARPENTER | X | | | | | R | | | |
| *Turbonilla laminata* CARPENTER | X | | R | R | | R | R | | |
| *Turbonilla latifundia* (DALL & BARTSCH), sp. nov. | E | R | | R | | R | R | | |
| *Turbonilla lowei* (DALL & BARTSCH), sp. nov | E | | R | R | | R | R | | |
| *Turbonilla muricata* GOULD | S | | C | C | | R | R | | |
| *Turbonilla pentalopha* (DALL & BARTSCH), sp. nov. | X | | | | | R | | | |
| *Turbonilla similimis* C. B. ADAMS | X | | C | C | | R | R | | |
| *Turbonilla stearnsii* (DALL & BARTSCH), sp. nov | S | | R | R | | | R | | |
| *Turbonilla subcuspidata* CARPENTER | S | | R | R | | R | R | | |
| *Turbonilla tenuicula* GOULD | X | | R | R | | R | R | | |
| *Turbonilla torquata* GOULD | X | | | | | R | | | |
| *Turbonilla torquata* var. *stylina* CARPENTER | N | | | | | R | R | | |
| *Turbonilla tridenta* CARPENTER | N | | | R | | R | R | | |
| *Turritella cooperi* CARPENTER | X | M | C | M | M | C | C | C | C |
| *Turritella jewetti* CARPENTER | E | R | R | | R | M | | C | |
| *Vermicularia*, sp. indet | ? | | | | | R | | | |
| *Vitrinella williamsoni* DALL | X | | R | | | R | | | |
| *Volvarina varia* SOWERBY | X | R | M | C | R | R | R | | |
| *Volvula cylindrica* CARPENTER | X | | | | | R | | | |
| **ANTHOZOA.** | | | | | | | | | |
| *Caryophyllia arnoldi* VAUGHAN | ? | | R | | | | | | |
| *Caryophyllia californica* (VAUGHAN), sp. nov | ? | | | | | | | R | |
| *Caryophyllia pedroensis* (VAUGHAN), sp. nov | ? | | R | | | | | | |
| *Paracyathus pedroensis* (VAUGHAN), sp. nov | ? | | R | | | | | | |
| **ECHINOIDEA.** | | | | | | | | | |
| *Echinarachnius excentricus* ESCHSCHOLTZ | X | R | C | M | M | C | M | | |
| *Strongylocentrotus franciscanus* AGASSIZ | X | | | | | C | | | |
| *Strongylocentrotus purpuratus* STIMPSON | X | | | | | C | | | |
| **BRYOZOA.** | | | | | | | | | |
| Bryozoan remains | ? | | | | | | | C | |
| **BRACHIOPODA.** | | | | | | | | | |
| *Laqueus jeffreysi* DALL | N | | | | | | | R | |
| *Terebratalia smithi*, sp. nov | E | | | | | | | R | |

| | Living. | Pleistocene. | | | | | | Pliocene. | |
|---|---|---|---|---|---|---|---|---|---|
| | | Upper San Pedro. | | | | Lower San Pedro. | | | |
| | San Pedro. | Deadman Island. | Lumber Yard. | Los Cerritos. | Crawfish George's. | Deadman Island. | San Pedro Bluffs. | Deadman Island. | Timm's Point. |
| **SCAPHOPODA.** | | | | | | | | | |
| *Cadulus nitentior* Carpenter | X | | | | | R | | | |
| *Dentalium indianorum* Carpenter | N | | | | R | M | R | | |
| *Dentalium hexagonum* Sowerby | X | C | C | C | C | C | M | | |
| *Dentalium pseudohexagonum* Dall | ? | | M | | | R | | | |
| *Dentalium semipolitum* Brodekip & Sowerby | S | R | R | | R | | | | |
| **CRUSTACEA.** | | | | | | | | | |
| *Balanus concavus* Bronn | X | R | M | M | R | | M | | |
| *Cancer breweri* Gabb | E | | | | | R | | | |
| **PISCES.** | | | | | | | | | |
| *Urolophus halleri* (?) Cooper | X | | R | | | | | | |

# CHAPTER II.

## THE UPPER PLIOCENE AND PLEISTOCENE FORMATION OF OTHER LOCALITIES OF THE PACIFIC COAST.

In discussing the occurrence of the Pleistocene deposits at other points along the Pacific Coast it will be necessary, in most instances, to quote the observations of others, as the writer has visited only a few of these localities.

The writer examined a raised beach at Blakeley Point, opposite Seattle, Washington, during the summer of 1900. It consists of sandy deposits lying horizontal upon the upturned and eroded edges of the Astoria Miocene strata. This beach and one or two others in the same vicinity are about ten or twelve feet above the level of Puget Sound, showing a total thickness of about ten feet; they are of late Pleistocene age, undoubtedly later than the last ice age of that country. The following species of marine mollusks in a rather poor state of preservation were obtained from the Point Blakeley raised beach:

*Macoma inquinata* *Purpura crispata* *Saxidomus aratus* *Tapes staminea*

Several deposits of a similar nature have been reported by J. P. Kimball[1] in the same vicinity. Dr. Kimball is of the opinion that there has been a recent elevation of the shores of the Sound of at least twenty-five feet. This uplift has taken place since the glacial drift was deposited in that region. Dall[2] reports a Pleistocene deposit, overlying beds of Pliocene age, from thirty to forty feet above the sea, near Bruceport, Washington.

Mr. H. W. Turner of the United States Geological Survey collected several specimens of sandstone containing the borings and shells of *Pholadidea penita* Conrad, from an elevation of fifty feet above tide water, at Fort Ross, Sonoma County, California. *Pholadidea penita* not occurring previously to the Pleistocene, this evidence shows that there has been a post-Pleistocene uplift of at least fifty feet at Fort Ross.

On the flanks of several of the little valleys draining into the Bay of San Francisco are deposits known to be of post-Pliocene age. Whitney describes some of these deposits, and makes correlations which are important, if correct. He says:[3]

"A post-Tertiary deposit made up of beds of gravel, sand, clay, and oyster

[1] Physiographic Geology of the Puget Sound Basin. By J. P. Kimball. Am. Geol., Vol. XIX, 1897, p. 231.
[2] Correlation Papers. Neocene. By W. H. Dall and G. D. Harris. Bull. U. S. Geol. Sur. No. 84, p. 228, 1892.
[3] Geological Survey of California. By J. D. Whitney, State Geologist. Geology, Vol. I, p. 102, 1865.

shells rests horizontally upon the upturned edges of the Cretaceous at several localities around Benicia. These are similar to the beds noticed as occurring on the shore between Martinez and Bull's Head Point, which contain fragments of bones of large animals and rolled Tertiary shells. Similar beds, with oysters, were observed on San Pablo Bay between Point Pinole and the Embarcadero; at this locality the beds containing oysters, which rest horizontally on upturned strata of the Tertiary, are elevated twenty feet above the level of the waters of the bay. At Benicia, also, there has been an elevation of several feet since the oyster beds were deposited. With the shells of oysters, those of other species, all now living in the waters of the bay, are found. These deposits evidently belong to the post-Pliocene, and they are of the same age as the beds of gravel, with boulders of gray sandstone, containing the bones of the mastodon and horse, which occur at Bottle Hill near Benicia."

The Pleistocene deposits on the shore of San Pablo Bay between the Union Oil Refinery and Point Pinole have been visited by Dr. Merriam and the writer. The deposits, which rest on the upturned edges of the San Pablo strata, consist of horizontally bedded layers of sand, gravel, and clay. Teeth of the mammoth, and bones of the giant sloth and extinct bison have been found in these Pleistocene layers by Dr. Merriam. In certain places the Pleistocene layers consist almost entirely of oyster and mussel shells.

LIST OF FOSSILS FROM THE PLEISTOCENE DEPOSITS ON SAN PABLO BAY BETWEEN THE UNION OIL REFINERY AND POINT PINOLE.

*Ostrea lurida* *Ostrea conchaphila* *Mytilus edulis* *Tagelus californianus*

The character of these Pleistocene strata and of their fauna leads the writer to correlate them with the upper San Pedro series.

Deposits of soft yellow sand resting on the Merced (Pliocene) strata in the vicinity of Lake Merced on the San Francisco peninsula have been assigned to the Pleistocene by Lawson[1] and Ashley.[2] The line of demarkation between the Pliocene and Pleistocene at some places mentioned by these authors seems to be in doubt. Both are agreed that there is an unconformity between the two series, and Ashley thinks that there was a period of subaërial erosion between them.

The Pleistocene deposits mentioned by Ashley[3] as occurring along the tops of the sea-cliffs from Montara Point south are partly of fresh-water and partly of marine origin. Those at Purissima are certainly of marine origin, for pholas borings have been found in the old beach-line on which they were deposited. The deposits along the upper edge of this same terrace in the vicinity of Halfmoon Bay are of fresh-water origin, and are very recent. The *Haliotis* mentioned by Ashley as occurring in these deposits are from Indian kitchen-middens, common at many places along the California coast. Similar kitchen-middens near San Mateo have been reported as Quarternary by the same writer.

[1] The Geology of the San Francisco Peninsula. By A. C. Lawson. 15th Ann. Rep. U. S. Geol. Surv., 1895, p. 463, *et seq.*

[2] The Neocene Stratigraphy of the Santa Cruz Mountains of California. By G. H. Ashley. Proc. Cal. Acad. Sci., 2nd ser., Vol. V, 1895, p. 347, *et seq.*

[3] *Op. cit.*, p. 349.

In the region surrounding Carmelo Bay[1] are numerous terraces strewn with boulders and pebbles, more or less cemented together, and in several cases with the adjoining rock surfaces showing borings which resemble those of *Pholadidea penita*. No fossils have been found in these deposits, but Lawson believes them to be of Pleistocene origin. He also believes that there was an interruption in the Pleistocene sedimentation, during which time orogenic movements took place. His conclusions are based on the finding of an unconformity between two of the terrace formations in a section north of Abalone Point.

Fairbanks[2] tells of a large area of Pleistocene sediments lying west of Corralitos Creek and north of the summit of the ridge. The beds are horizontal and consist of indistinctly stratified and slightly consolidated sand. This sand formation reaches a maximum thickness of about three hundred feet. Fragments of shells are found over the surface of the deposits up to an elevation of nine hundred feet. The only shells positively identified from the surface of the beds are:

*Chlorostoma brunneum* *Haliotis (?)* *Lunatia lewisii* *Mytilus californicus* *Purpura canaliculata*

This fauna is similar to that of the Indian kitchen-middens found at so many places along the coast, and it seems probable that the shells are from deposits of this kind. Their occurrence on the surface would add weight to this theory. Another Pleistocene area in this Point Sal district is at the head of the valley north of the dairy, and consists of fragments of bituminous shale, and a deposit of calcium carbonate containing casts of *Crepidula rugosa* and a species of *Purpura*. Fairbanks says these beds are similar to those of Point Loma, near San Diego, "even to the presence on the surface of small concretionary nodules of sand cemented by iron oxide."[3]

From Mallagh Landing, two miles southeast of Port Harford, to Pismo, and from Surf to Santa Barbara the sea-cliffs are capped by deposits of sand and gravel which are probably of Pleistocene age. No fossils were found in any of the localities visited; but in several places, noticeably northwest of Pismo, pholas-bored pebbles were found at the contact between the Pleistocene sands and the underlying eroded Miocene shale, thus showing the marine origin of the Pleistocene deposits.

## Santa Barbara and Vicinity.

The Packard's Hill deposits are the most important of the fossiliferous beds in the immediate vicinity of Santa Barbara. Packard's Hill is a ridge about three hundred feet in height, which begins a short distance northwest of the western end of the beach boulevard, and extends for nearly a mile due north. Its eastern slope is almost precipitous, and outcrops of the fossil-bearing strata are found over the whole slope. The best outcrops, and the one from which all the fossils were obtained by the writer, are about two-thirds of the way up the hill. The hill consists of layers of fine, soft, light yellow sand and marl, which is hardened in places

[1] The Geology of Carmelo Bay. By A. C. Lawson. Bull. Dept. Geol., Univ. Cal., Vol. I., p. 52, *et seq.*
[2] The Geology of Point Sal By H. W. Fairbanks. Bull. Dept. Geol., Univ. Cal., Vol. II., 1896, p. 6-8.
[3] *Op. cit.*, p. 8.

by the lime leached from shells. The dip of the beds is nearly due south at an angle of 15°. The hardened strata are darker colored than the softer beds, and as a rule are more fossiliferous. The fossils in the soft strata are very fragile, but by using care some fine specimens may be obtained from them.

The fauna of the Packard's Hill deposits is similar to that of the upper horizon of the San Diego formation, and is probably equivalent to that part of the Pliocene which is missing between the Deadman Island Pliocene and the overlying lower San Pedro series (Pleistocene). The close relation between the *Pecten bellus* Conrad found in the Packard's Hill Pliocene and the *Pecten hemphilli* Dall of the upper horizon in the San Diego formation is an indication of a more or less close relation between the two formations. *Pecten bellus, Terebratalia hemphilli, Laqueus jeffreysi,* and *Venus perlaminosa* are the most characteristic specimens found at Packard's Hill.

A bluff nearly thirty feet in height begins just west of the western end of the beach boulevard at Santa Barbara, and extends southwest along the ocean. For the first eighth of a mile, or along the edge of the first cove, the bluff consists of rather evenly bedded, soft, brownish yellow, sandy marl, which dips S. 30° E. 14°. Around the point one-eighth mile southwest of the bath-house the bluff consists of irregularly bedded gravels and sand, which seem at some places to rest unconformably upon the fossiliferous marl beds, although false bedding is so prevalent in the deposits along this bluff that any positive evidence as to the conformability of the strata was hard to obtain. Further southwest along the coast, the gravels and sand rest upon the upturned and eroded edges of the contorted Miocene shales. At one place about half a mile south of the bath-house, where these Pleistocene sands and gravels rest upon the Miocene shales, the Pleistocene deposits were impregnated with asphaltum. In this same place a fragment of the fossiliferous sandstone, similar to that which is found at the northern end of the bluff near the bath-house, was found in the Pleistocene gravels; thus giving evidence that there are two distinct horizons in the Pleistocene along this bluff.

Alternating strata of sand and gravel, showing false bedding, are exposed in the sea-cliff east of the Santa Barbara wharf. A stratum of shell fragments was found near the western end of this cliff, but no specific determination of the fossils could be made on account of their poor state of preservation. The strata of this bluff are similar to, and probably contemporaneous with, the late Pleistocene strata in the bluff southwest of the bath-house.

LIST OF FOSSILS COLLECTED FROM THE PLIOCENE AND PLEISTOCENE FORMATIONS OF SANTA BARBARA, CALIFORNIA.

| | Bath-house Pleistocene. | Packard's Hill Pliocene. |
|---|---|---|
| *Acmæa insessa* HINDS | X | |
| *Admete gracilior* CARPENTER | X | |
| *Amphissa corrugata* REEVE | X | |
| *Balanus concavus* BRONN | | X |
| *Bela fidicula* GOULD | X | |
| *Bittium asperum* GABB | X | |
| *Bittium quadrifilatum* CARPENTER | X | |
| *Bryozoa* sp. (?) | X | |
| *Cardium corbis* MARTYN | X | |
| *Calliostoma gemmulatum* CARPENTER | | X |
| *Chrysodomus tabulatus* BAIRD | X | |
| *Clathurella conradiana* GABB | X | X |
| *Columbella (Astyris) gausapata* GOULD | X | |
| *Columbella (Astyris) gausapata* var. *carinata* HINDS | X | |
| *Columbella (Astyris) tuberosa* CARPENTER | X | |
| *Crepidula adunca* SOWERBY | X | |
| *Crepidula navicelloides* NUTTALL | X | |
| *Cythara branneri*, sp. nov. | X | |
| *Diastoma*, sp. (?) | X | |
| *Fusus robustus* TRASK | X | |
| *Galerus mammillaris* BRODERIP | X | X |
| *Glottidia albida* HINDS | | X |
| *Lacuna compacta* CARPENTER | X | |
| *Laqueus jeffreysi* (?) DALL | | X |
| *Leptothyra bacula* CARPENTER | X | |
| *Leptothyra paucicostata* DALL | X | |
| *Lucina acutilineata* CONRAD | X | |
| *Lucina californica* CONRAD | X | |
| *Macoma* sp. (?) | X | |
| *Mangilia angulata* CARPENTER | X | |
| *Mangilia interfossa* var. *pedroana*, var. nov. | X | |
| *Margarita pupilla* GOULD | X | |
| *Mitramorpha intermedia*, sp. nov. | X | |
| *Modiola fornicata* CARPENTER | X | |
| *Nassa mendica* GOULD | X | |
| *Natica clausa* BRODERIP & SOWERBY | X | X |
| *Ocinebra barbarensis* GABB | X | |
| *Ocinebra lurida* var. *aspera* BAIRD | X | |
| *Ocinebra perita* HINDS | X | |
| *Odostomia nuciformis* var. *avellana* CARPENTER | X | |
| *Odostomia gouldii* CARPENTER | X | |
| *Olivella biplicata* SOWERBY | X | |
| *Panopea generosa* GOULD | | X |
| *Pecten bellus* CONRAD | | X |
| *Pecten caurinus* GOULD | X | X |
| *Pecten hastatus* SOWERBY | X | X |
| *Pecten jordani*, sp. nov. | | X |
| *Pecten opuntia* DALL | | X |
| *Pododesmus macroschisma* DESHAYES | X | |
| *Protocardia centifilosa* CARPENTER | X | X |
| *Psephis salmonea* CARPENTER | X | X |
| *Puncturella cuculata* GOULD | | X |
| *Strongylocentrotus purpuratus* STIMSON | X | |
| *Terebratalia hemphilli* DALL | | X |
| *Tornatina culcitella* GOULD | X | |
| *Trophon gracilis* PERRY | X | |
| *Trophon orpheus* var. *præcursor*, var. nov. | X | |
| *Turbonilla tridenta* CARPENTER | X | |
| *Venericardia barbarensis* STEARNS | X | X |
| *Venericardia ventricosa* GOULD | X | X |
| *Venus perlaminosa* CONRAD | X | X |

Recognizable fossils are found only in the few beds of soft, brownish-yellow marl at the northeastern end of the bluff west of the bath-house. The lowest strata exposed near the bath-house consist almost wholly of bryozoan remains, among which are scattered a few shells. The bryozoan remains give place to sand in the beds a

few feet above. The large shells in the strata are poorly preserved, but the smaller fossils, especially the gastropods, are abundant and well preserved.

The fauna of the beds west of the bath-house is similar to that of the lower San Pedro series (lower Pleistocene) of Deadman Island, and these Santa Barbara beds are probably contemporaneous with the lower San Pedro deposit of Deadman Island. Several nearly perfect tests of *Strongylocentrotus purpuratus* were found in the bath-house strata, the first tests of this species that have been recorded from the Pleistocene. *Echinarachnius excentricus* was also found in the same bed. The stratigraphic relation between the Packard's Hill and bath-house beach fossiliferous deposits was not obtained, but the former are probably the older strata, although both may belong to the same series and be nearly contemporaneous.

Lithologically the two beds are somewhat similar, but faunally they differ considerably. The absence of *Pecten bellus, Terebratalia hemphilli, Laqueus jeffreysi* and *Pecten opuntia* from the bath-house beach strata; and the absence of the two species of echinoderms and many species of gastropods from the Packard's Hill beds, are the noticeable differences between the two faunas.

Whitney mentions the following localities, besides those already cited, where Pleistocene deposits were found by the State Survey: At Hill's Ranch,[1] about six miles west of Santa Barbara, "the bituminous slate is covered unconformably, as at Santa Barbara, by a heavy deposit of post-Pliocene age, which here attains a thickness of from eighty to one hundred feet. The bituminous slates, which are highly contorted and turned upon edge, lie nearly on a level with the ocean; and on their edges rests a body of soft, arenaceous, and loose gravelly materials, sometimes very slightly consolidated, and in which are long fissures filled with asphaltum." On the southwestern face[2] of Santa Barbara Island is a raised beach thirty feet above tide level, containing marine shells, which Whitney thinks is the same formation as that found at Santa Barbara. Near the Santa Maria River the hills of Miocene shale are capped with horizontal post-Pliocene deposits.[3]

Dr. Stephen Bowers[4] describes the Pleistocene of Santa Rosa Island from notes taken by Dr. L. G. Yates: "On the north side of the island, about ten miles from the wharf, and near the mouth of Soledad Canyon, there is a fine exposure of strata consisting of about ninety feet of post-Pliocene deposits, containing fossil bones of vertebrates and at one place fossil Physas, at a depth of some seventy-five feet below the surface. This deposit is horizontal and overlies strata of older rocks, probably Pliocene, which dip 13° northeast, and contain Pectens and Turbinellas in abundance."

Judging by the fauna of the Pleistocene deposits on Santa Rosa Island, they are probably of fresh-water origin. An elephant's tooth and other elephant remains are reported by Dall[5] as having been found by W. G. Blunt and Voy on Santa Rosa Island.

*Ventura.*—The most striking thing in relation to the geology of the vicinity of

[1] Geological Survey of California. By J. D. Whitney, State Geologist. Geology, 1865, Vol. 1, p. 132.
[2] *Op. cit.*, p. 183.
[3] *Op. cit.*, p. 137.
[4] Santa Rosa Island. By Rev. Stephen Bowers. Smithsonian Report, 1877, p. 317.
[5] Correlation Papers. Neocene. By W. H. Dall and G. D. Harris. Bull. U. S. Geol. Sur., No. 84, 1892, p. 217.

Ventura is the great development and the high elevation above sea-level of the Pleistocene deposits in that locality. The terrace on which the city is located and the hills immediately back of the city are of Pleistocene origin. This is shown by the marine fauna collected at different localities in the vicinity.

The first locality visited was along the course of the old irrigating ditch, which runs at an elevation of about two hundred and fifty feet above sea-level on the eastern side of the valley west of Ventura. The hills along which this ditch runs rise to over five hundred feet in height, and are composed of fine, soft, yellow sandstones which dip south at an angle of 50°. These sandstones were examined for about one-half mile north of Ventura along the ditch. This exposure represents a thickness of at least one thousand feet. Several of the strata were fossiliferous and yielded a fauna similar to that of the Pleistocene of San Pedro. The upper beds, or those nearest the ocean, contained a fauna similar to the upper San Pedro series, while that of the beds further down in the series contained such species as are commonest in the lower San Pedro series. The lower beds were characterized by the great abundance of *Turritella cooperi*. An outcrop in a ravine near the new hospital on the north side of Ventura contained a fauna similar to that of the upper beds along the ditch.

There is an exposure of fossiliferous Pleistocene strata between Barlow's ranch house, three miles east of Ventura, and a prominent point, called "The Peak," north of the house. "The Peak" has an elevation of one thousand and seventy feet, according to the United States Coast and Geodetic Survey. The highest point at which fossils were obtained was about two hundred and fifty feet below the summit, but the same formation extends to the top, and probably comprises all of the sediments forming the elevated ridge which lies back of Ventura from the ocean, and extends parallel with the coast for several miles east of Ventura.

The fossiliferous strata exposed were about twenty-five feet thick, and consisted of five or six layers of shells from three to nine inches in thickness, separated by fine, soft, light yellow sand layers. The whole series was unconsolidated, except for local hardenings in the shell layers, and was oxidized but little. The dip of the strata was from 30° to 40° south, which corresponded nearly to the general slope of the main ridge, whose axis was parallel with the coast, and of which "The Peak" was the highest point.

The fauna collected consisted of about fifty species, all of which are common to the San Pedro series. The similarity between this fauna and that of the upper San Pedro series, and the incoherency and lack of oxidation of the matrix, leave little doubt as to the age of these beds. They are of Pleistocene origin, and, moreover, are synchronous with the upper San Pedro series. Their elevation of about eight hundred feet above the sea-level seems remarkable, but only confirms the theory of the recent great elevation of the coast of California from San Francisco southward.

LIST OF FOSSILS COLLECTED FROM THE PLEISTOCENE FORMATIONS IN THE VICINITY OF VENTURA, CALIFORNIA.

| | Barlow's ranch. | Irrigating ditch. | | Barlow's ranch. | Irrigating ditch. |
|---|---|---|---|---|---|
| *Acmæa pelta* ESCHSCHOLTZ | X | | *Modiola fornicata* CARPENTER | X | |
| *Actæon (Rictaxis) punctocælata* CARPENTER | X | | *Monoceros engonatum* CONRAD | X | |
| *Angulus buttoni* DALL | X | | *Nassa californiana* CONRAD | X | |
| *Anomia lampe* GRAY | X | | *Nassa fossata* GOULD | X | X |
| *Balanus concavus* BRONN | X | | *Nassa mendica* GOULD | X | X |
| *Bela fidicula* GOULD | | X | *Nassa perpinguis* HINDS | X | X |
| *Bittium asperum* GABB | X | | *Neverita recluziana* PETIT | X | X |
| *Cadulus nitentior* CARPENTER | X | | *Neverita recluziana* var. *alta* DALL | X | X |
| *Cancellaria tritonidea* GABB | X | X | *Ocinebra lurida* var. *aspera* BAIRD | | X |
| *Chione succincta* VALENCIENNES | X | | *Odostomia gouldii* CARPENTER | X | |
| *Chlorostoma funebrale* A. ADAMS | X | | *Odostomia nuciformis* var. *avellana* CARPENTER | X | X |
| *Chorus belcheri* HINDS | X | | *Odostomia tenuis* CARPENTER | X | X |
| *Chrysodomus tabulatus* BAIRD | | X | *Olivella biplicata* SOWERBY | X | X |
| *Columbella (Astyris) gausapata* GOULD | X | X | *Olivella intorta* CARPENTER | X | X |
| *Columbella (Astyris) gausapata* var. *carinata* HINDS | X | X | *Olivella pedroana* CONRAD | X | |
| *Crepidula adunca* SOWERBY | X | | *Pecten latiauritus* var. *monotimeris* CONRAD | X | |
| *Cryptomya californica* CONRAD | X | X | *Pecten ventricosus* SOWERBY | | X |
| *Cylichna alba* BROWN | X | | *Pleurotoma carpenteriana* GABB | | X |
| *Dentalium hexagonum* SOWERBY | X | | *Purpura saxicola* VALENCIENNES | | X |
| *Donax lævigata* DESHAYES | X | | *Rissoa acutelirata* CARPENTER | | X |
| *Drillia hemphilli* STEARNS | X | | *Saxidomus aratus* GOULD | X | |
| *Drillia inermis* HINDS | X | X | *Scala crebricostata* CARPENTER | X | X |
| *Drillia inermis* var. *penicillata* CARPENTER | X | X | *Scala tincta* CARPENTER | X | |
| *Echinarachnius excentricus* ESCHSCHOLTZ | X | | *Tapes tenerrima* CARPENTER | X | |
| *Eulima micans* CARPENTER | X | | *Terebra simplex* CARPENTER | X | |
| *Eulima hastata* SOWERBY | X | | *Tornatina culcitella* GOULD | X | |
| *Lacuna compacta* CARPENTER | X | | *Tornatina harpa* DALL | X | |
| *Littorina scutulata* GOULD | X | | *Turritella cooperi* CARPENTER | X | X |
| *Macoma nasuta* CONRAD | X | X | *Turbonilla laminata* CARPENTER | X | |
| *Mactra catilliformis* CONRAD | X | | *Turbonilla*, four sp. (?) | X | |
| *Mangilia angulata* CARPENTER | X | | *Yoldia cooperi* GABB | X | |
| *Mangilia* sp. (?) | | X | | | |

Watts and Cooper give lists of fossils from several localities in Santa Barbara, Ventura and Los Angeles counties[1] which suggest the Pleistocene age of the deposits

[1] The Gas and Petroleum Yielding Formations of the Central Valley of California. By W. L. Watts. Bull. Cal. State Mining Bureau, No. 3, 1894.

Lists of Fossils Identified by Dr. J. G. Cooper. Oil and Gas Yielding Formations of Los Angeles, Ventura, and Santa Barbara counties. By W. L. Watts. Bull. Cal. State Mining Bureau, No. 11, 1897, pp. 79–87.

from which the fossils were taken. The faunas are generally so small, and the stratigraphic notes so incomplete, that it is not possible to make any definite correlations between these deposits and the different horizons of the San Pedro series.

*Port Los Angeles.*—The writer has obtained the following species from a hard, sandy stratum underlying more than a hundred feet of soft, sandy deposits in the mouth of the canyon at the end of the large wharf at Port Los Angeles, near Santa Monica:

*Astyris gausapata*
*Bela sanctæ-monicæ*
*Bittium asperum*
*Nassa mendica* var. *cooperi*
*Nassa perpinguis*
*Neverita recluziana*
*Olivella biplicata*
*Olivella intorta*
*Ostrea lurida* (?)
*Pisania fortis*
*Pleurotoma carpenteriana*
*Pleurotoma perversa*
*Tapes staminea*
*Turritella cooperi*
*Trophon scalariformis*
*Venericardia ventricosa*

The stratum from which the above fossils were obtained is probably Pleistocene, corresponding to the lower San Pedro series of Deadman Island, for lithologically and faunally the strata are quite similar. The overlying beds are soft and unfossiliferous, and lie slightly unconformably on the lower fossiliferous stratum; and although they contain no fossils, still, from lithological and stratigraphical reasons, it is probable that they are equivalent to the upper San Pedro deposits. These Pleistocene strata extend down the coast from the great wharf to about one-half mile below Santa Monica.

*San Clemente Island.*—The post-Pliocene deposits of San Clemente Island are small. W. S. T. Smith[1] says that they consist of fine sand and rolled pebbles, and have a maximum thickness of only ten feet. *Lucina californica* is the only fossil shell reported from these deposits.

*Newport.*—Much of the coast line from Long Beach to San Diego consists of more or less elevated deposits of Pleistocene age. Deposits of Pleistocene age have been examined by W. L. Watts in the vicinity of Newport, Orange county.[2] About a mile north of the town of Newport is a formation of soft sandstone and yellowish clay-shale, with layers of hard calcareous strata, and some strata which appear to be made up largely of diatomaceous material. These deposits contain the following species, which have been identified by Dr. J. C. Merriam:

*Anomia lampe*
*Cardium panamense* [=*C. procerum*]
*Chione simillima*
*Chione succincta*
*Crucibulum spinosum*
*Macoma inquinata*
*Neverita recluziana*
*Pecten æquisulcatus* [?=*P. ventricosus*]
*Placunanomia macroschisma*
*Pomaulax undosus*
*Tapes staminea*
*Zirphæa crispata* [=*Z. Gabbi*]

The fauna given above shows that this deposit is equivalent to the upper San Pedro series.

The oil-sand and sandstone west of the inner bay at Newport contain the following species:[3]

*Bittium asperum*
Bryozoan remains
*Crepidula adunca*
*Lucina californica*
*Macoma inquinata*
*Monoceros engonatum*
*Nassa fossata*
*Nassa perpinguis*
*Olivella biplicata*
*Petricola carditoides*
*Tapes staminea*

This fauna corresponds to that of the upper San Pedro series, although no definite relation can be established, owing to the lack of characteristic fossils.

[1] A Geological Sketch of San Clemente Ieland. By W. S. T. Smith. 18th Ann. Rept. U. S. Geol. Sur., Part II., 1898, p. 492.
[2] Oil and Gas Yielding Formations of California. By W. L. Watts. Bull. Cal. State Mining Bureau, No. 19, 1900, pp. 61 and 223.
[3] *Op. cit.*, p. 233.

*San Juan Capistrano.*—The following fossils were taken from a shallow well at San Juan Capistrano, in which were also found a tusk and some of the bones of a mastodon:[1]

| | | |
|---|---|---|
| *Arca* (cf.) *sulicosta* | *Natica ciausa* | *Turritella cooperi* |
| *Crepidula excavata* | *Ostrea* (?) | *Venericardia borealis* [=*V. ventricosa*] |
| *Nassa mendica* | *Leda* (?) | *Vola* (?) |

Dr. Merriam is of the opinion that these fossils are of Pliocene age—an opinion borne out by the similarity of this fauna to that of the Deadman Island Pliocene.

At Bell Station, on the Los Angeles Terminal Railway in Los Angeles County, the following fossils were obtained from a well at a depth of between 920 and 1,320 feet.[2]

| | | |
|---|---|---|
| *Amiantis callosa* | *Myurella* (aff.) *simplex* [=*Terebra* id.] | *Olivella bœtica* [=*O. pedroana*] |
| *Echinarachnius excentricus* | | *Rœta undulata* |
| *Macoma nasuta* | *Lunatia lewisii* | *Tornatella* (?) |

This is an upper San Pedro fauna, and its occurrence at such a great depth has much significance in showing the great amount of sedimentation that has taken place in the region between Los Angeles and the ocean since the deposition of the San Pedro series.

### San Diego and Vicinity.[3]

The Pliocene and Pleistocene deposits of San Diego are similar to those of San Pedro, and the geologic history of the two regions has been nearly the same. During the Pliocene epoch the region now occupied by San Diego Bay and vicinity was a great basin in which coarse gravels and fine sands were deposited. The earlier sediments, which are now exposed along the northern portion of the San Diego mesa, consist of thick deposits of incoherent coarse gravels, while the later deposits are made up of plainly bedded yellow sandstones. After the deposition of these layers, there was an interruption of sedimentation, which was followed during Pleistocene times by an inundation and deposition of fossiliferous gravels and sands over much of the San Diego region.

*Pacific Beach—Pliocene.*—The best exposure of the Pliocene is found at Pacific Beach, on the coast ten miles north of San Diego. A perpendicular bluff, varying in height from four feet at Ocean Front to over sixty feet one mile north, forms the coast line of Pacific Beach. This bluff is composed of brownish yellow sandstones of Pliocene age, which dip gently toward the south, and disappear successively beneath the beach as one approaches Ocean Front from the north. The total thickness of the strata exposed is about two hundred feet. The upper one hundred feet are fossiliferous, while the lower layers are devoid of fossils. The unfossiliferous sandstone rests upon coarse incoherent gravels of unknown thickness.

There appear to be two quite distinct horizons in the fossiliferous section of the Pacific Beach Pliocene. Stratigraphically no distinction can be made, as the whole series of strata rest conformably upon one another, but faunally there is

[1] *Op. cit.*, pp. 59 and 222.

[2] *Op. cit.*, p. 223.

[3] The late Tertiary and Pleistocene formations in the vicinity of San Diego are mentioned in the following papers:
Distribution of California Tertiary Fossils. By W. H. Dall. Proc. U. S. Nat. Museum, Vol. I, 1879, pp. 26-30.
North American Tertiary Horizons. By W. H. Dall. 18th Ann. Rept. U. S. Geol. Sur., Part II, 1898, p. 335.
Geology of San Diego County; also of portions of Orange and San Bernardino Counties. By H. W. Fairbanks. 11th Ann. Rept. Cal. State Mineralogist, 1893, pp. 76-120.

much difference between the two horizons. The lower fossiliferous strata are distinguished by *Pecten expansus, Pecten stearnsii, Opalia anomala*, and *Opalia varicostata*, *Pecten expansus* being very numerous. The upper beds have few *Pecten expansus*, but are characterized by *Pecten hemphilli*, which completely replaces the *Pecten stearnsii* of the lower layers. *Echinarachnius excentricus* and *Crepidula grandis* are also common in the upper layers.

The series of Pliocene strata exposed at Pacific Beach has been named the San Diego formation by Dall,[1] who places it below the Merced formation. At another place in this paper the writer brings forward reasons for placing the San Diego formation above the Merced. Besides the reasons given at that place (page 17) there is other evidence showing that the San Diego formation is part of the latest Pliocene. This is the occurrence in it of *Echinarachnius excentricus*. This species of echinoderm is not found in the Merced series or in any of the underlying formations, so far as known, but is found in the lower San Pedro series (lowest Pleistocene) and in all of the succeeding formations, and is still living. Considering the short geologic range usually covered by species of echinoderms, this evidence strongly favors the theory that the San Diego formation is at the top of the Pliocene, and probably takes in a part of the lower San Pedro series.

The lithologic and stratigraphic similarity of the San Diego formation to the Deadman Island Pliocene is marked. Both consist of rather fine, brownish yellow sand strata only moderately consolidated, except locally, with low dip, and showing the effect of only a slight movement since their deposition. Both formations are overlain unconformably by strata of Pleistocene origin. The faunal aspects of the two formations are somewhat different. *Pecten expansus* of the San Diego formation replaces *Pecten caurinus*, which is abundant in the Pliocene of Deadman Island, and numerous species are found in the Deadman Island Pliocene which do not occur in the Pacific Beach Pliocene deposits. *Pecten stearnsii* is common to both formations, and as its geologic range is very limited, it is strong evidence of the contemporaneity of the two formations. Correlating more accurately, the Deadman Island Pliocene is probably contemporaneous with the lower (Pliocene) horizon at Pacific Beach, for *Pecten stearnsii* is limited to that horizon in the San Diego formation, so far as is known.

*Pacific Beach—Pleistocene.*—The upper six to ten feet of the Pacific Beach bluff is composed of a gravel and sand formation which rests unconformably upon the Pliocene strata. The line of demarkation between the Pliocene and the upper Pleistocene formation is generally distinct, as the lower layer of the Pleistocene is of coarse, fossiliferous gravel, while the underlying Pliocene strata are of fine sand. Well preserved fossils are found at many points in this Pleistocene layer along Pacific Beach, while at other places in the same stratum the fossils are so brittle that it is impossible to remove them from the soft matrix. The fauna of this Pleistocene stratum is very similar to that of the upper San Pedro deposits exposed at the north point of the San Pedro bluff. The break between the faunas of the Pacific Beach Pliocene and the overlying Pleistocene is much greater than that between the Deadman Island Pliocene and its overlying Pleistocene (lower San Pedro series) layer.

[1] North American Tertiary Horizons. By W. H. Dall. 18th Ann. Rept. U. S. Geol. Survey, Part II, 1898, p. 335.

*San Diego Mesa—Pliocene.*—The San Diego mesa is composed of Pliocene strata. Outcrops of the soft yellow and brown Pliocene sandstone occur in many places in the northern part of the city. A good exposure is found at the north end of Tenth street, a short distance northwest of the Russ school, where a cut on both sides of a small ravine reveals a section of the Pliocene about fifty feet thick. This exposure is only about two hundred feet north of the "San Diego well," which was dug about twenty years ago, and which has become famous through the discussion of the age of the fossils which were taken from it. Mr. Hemphill, who obtained the fossils from this well during its excavation, informed the writer that fossiliferous strata were penetrated to a depth of one hundred and forty-nine feet. As the exposure of the San Diego formation above the mouth of the well is fifty feet thick, the fossil-bearing strata of the Pliocene formation of the San Diego mesa are at least two hundred feet in thickness. The dip of the strata above the well is south, or toward the bay, at an angle of eight or ten degrees.

*Twenty-sixth Street—Pleistocene.*—A bluff about eighteen feet high rises from the edge of the bay at the foot of Twenty-sixth street, San Diego, and extends for two or three blocks both toward the east and toward the west from Twenty-sixth street, forming the shore line along this part of the bay. At the base of this bluff, and covered by the water at high tide is a stratum six inches thick made up almost entirely of the upper valves of *Anomia limatula*. No right valves were found in this deposit, and this species seemed to be restricted to this layer. A stratum of fine, yellow fossiliferous sand, four or five feet thick, rests upon the *Anomia* beds; and above the fossiliferous bed is about twelve feet of fine brown sand, overlain by sandy soil. *Dosinia ponderosa*, *Callista newcombiana*, *Mactra californica*, and *Cardium procerum* are the predominating species in the yellow sand stratum. The fauna of this locality is equivalent to that of the upper San Pedro series at San Pedro.

*Spanish Bight—Pleistocene.*—The Coronado peninsula is a long, low, narrow sand-spit lying between San Diego Bay and the ocean. Near its western end is a small inlet on the bay side, known as Spanish Bight. The western shore-line of this inlet is a bluff varying in height from twelve to eighteen feet, while the stratum at the base of the bluff forms the beach, and is covered by the water at high tide. This lowest layer is composed of a firm, fine brown sand in which are imbedded numerous large *Amiantis callosa*, which have the appearance of living shells, so naturally do they lie on the sand. An attempt to remove them, however, dispels the delusion, for in most cases they are quite firmly imbedded in the sand layer.

There are three feet of fine, soft, unfossiliferous gray sand above the *Amiantis* layer, and this is overlain by a deposit, varying in thickness from three to five feet, of soft gray sand, which is very fossiliferous near its base and gradually grades into the almost unfossiliferous gray sand a few feet above. About twelve feet from the base of the bluff is a layer from three to six inches thick containing numerous *Donax lævigata* cemented together. This Donax layer is the uppermost fossiliferous stratum, the bluff above this being composed of unfossiliferous sands. The fauna of the Spanish Bight deposits is similar to that of the upper San Pedro series at Los Cerritos, and the deposits are probably of contemporaneous origin.

## List of Fossils Collected from the Pliocene and Pleistocene Formations of San Diego, California.

| | Pleistocene. | | | Pliocene. | |
|---|---|---|---|---|---|
| | Foot of 26th street. | Spanish Bight. | Pacific Beach. | Pacific Beach. | Russ School. |
| *Acmæa insessa* Hinds | | X | | | |
| *Acmæa pelta* Eschscholtz | | | X | | |
| *Actæon traskii* Stearns | | X | | | |
| *Actæon (Rictaxis) punctocælata* Carpenter | | X | | | |
| *Amiantis callosa* Conrad | | X | | | |
| *Amphissa versicolor* Dall | | | X | | |
| *Anomia lampe* Gray | | X | X | | |
| *Anomia limatula* Dall | X | | | | |
| *Astarte branneri*, sp. nov. | X | | | | |
| *Balanus concavus* Bronn | | X | X | | X |
| *Bittium asperum* Gabb | | | X | | |
| *Bittium williamsoni*, sp. nov. | | X | | | |
| *Cadulus nitentior* Carpenter | | X | | | |
| *Callista newcombiana* Gabb | X | | | | |
| *Calliostoma canaliculatum* Martyn | | X | | | |
| *Calliostoma costatum* Martyn | | | X | | |
| *Calliostoma gemmulatum* Carpenter | | X | | | |
| *Calliostoma tricolor* Gabb | | X | | | |
| *Cancer*, sp. indet | | X | | | |
| *Cardium procerum* Sowerby | X | X | | | |
| *Cardium quadrigenarium* Conrad | X | | X | | |
| *Cerithidea californica* Haldemann | X | | X | | |
| *Chione fluctifraga* Sowerby | X | | | | |
| *Chione simillima* Sowerby | X | | | | |
| *Chione succincta* Valenciennes | X | | | | |
| *Chlorostoma funebrale* A. Adams | | | | | |
| *Chlorostoma gallina* Forbes | | | X | | |
| *Chlorostoma montereyi* Kiener | | | X | | |
| *Clidiophora punctata* Conrad | | X | | | |
| *Clypidella bimaculata* Dall | X | | | | |
| *Columbella (Æsopus) chrysalloidea* Carpenter | X | | | | |
| *Columbella (Astyris) gausapata* Gould | X | | X | | |
| *Columbella (Astyris) gausapata* var. *carinata* Hinds | | X | | | |
| *Columbella (Astyris) tuberosa* Carpenter | | X | | | |
| *Conus californicus* Hinds | | X | X | | |

| | Pleistocene. | | | Pliocene. | |
|---|---|---|---|---|---|
| | Foot of 26th street. | Spanish Bight. | Pacific Beach. | Pacific Beach. | Russ School. |
| *Cooperella subdiaphana* Carpenter | | X | | | |
| *Corbula luteola* Carpenter | X | | | | |
| *Crepidula adunca* Sowerby | | X | | | |
| *Crepidula grandis* Middendorf | | | | X | |
| *Crepidula onyx* Sowerby | | X | X | | |
| *Crucibulum spinosum* Sowerby | X | | X | | |
| *Cryptomya californica* Conrad | X | X | | | |
| *Cylichna alba* Brown | | X | | | |
| *Delphinoidea coronadoënsis*, sp. nov | | X | | | |
| *Dentalium hexagonum* Sowerby | X | X | X | X | X |
| *Dentalium pseudohexagonum* Dall | | X | | | |
| *Diplodonta orbella* Gould | X | | | | |
| *Diplodonta serricata* Reeve | X | | | | |
| *Donax lævigata* Deshayes | X | X | X | | |
| *Dosinia ponderosa* Gray | X | | | | |
| *Drillia cancellata* Carpenter | | X | | | |
| *Drillia hemphilli* Stearns | X | X | | | |
| *Drillia incisa* Carpenter | | | X | | |
| *Drillia inermis* Hinds | | X | X | | |
| *Drillia inermis* var. *penicillata* Carpenter | | X | X | | |
| *Echinarachnius excentricus* Eschscholtz | X | X | X | X | X |
| *Eulima hastata* Sowerby | | X | | | |
| *Eulima micans* Carpenter | | X | | | |
| *Eupleura muriciformis* Broderip | X | | | | |
| *Fissurella volcano* Reeve | | | X | | |
| *Glycymeris barbarensis* Conrad | | | X | | |
| *Haliotis fulgens* Philippi | | X | | | |
| *Hipponyx cranioides* Carpenter | | X | | | |
| *Hipponyx tumens* Carpenter | | | X | | |
| *Kellia laperousii* Deshayes | | X | | | |
| *Lævicardium substriatum* Conrad | X | | | | |
| *Lacuna compacta* Carpenter | | X | | | |
| *Lacuna solidula* (Loven) Carpenter | | | X | | |
| *Lamellaria stearnsii* Dall | X | | | | |
| *Leda hamata* Carpenter | | X | | | |
| *Leda taphria* Dall | | X | X | X | |
| *Littorina scutulata* Gould | | X | X | | |
| *Lucina acutilineata* Conrad | | | X | | |

| | Pleistocene. | | | Pliocene. | |
|---|---|---|---|---|---|
| | Foot of 26th street. | Spanish Bight. | Pacific Beach. | Pacific Beach. | Russ School. |
| *Lucina californica* Conrad | | | X | | |
| *Lucina nuttalli* Conrad | X | | X | X | |
| *Lucina tenuisculpta* Carpenter | | X | | | |
| *Macoma indentata* Carpenter | | X | | | |
| *Macoma inquinata* Deshayes | X | | | | |
| *Macoma nasuta* Conrad | | X | X | X | |
| *Macoma nasuta* var. *kelseyi* Dall | X | | | | |
| *Macoma secta* Conrad | | X | | | |
| *Macoma yoldiformis* Carpenter | | X | | | |
| *Mactra californica* Conrad | X | | | | |
| *Mactra (Spisula) catilliformis* Conrad | X | X | X | X | |
| *Mactra exoleta* Gray | | X | X | | |
| *Mactra (Spisula) falcata* Gould | | X | | | |
| *Mangilia angulata* Carpenter | | X | X | | |
| *Mangilia striosa* C. B. Adams | | X | | | |
| *Melampus olivaceus* Carpenter | X | | | | |
| *Metis alta* Conrad | | X | | X | |
| *Modiola recta* Conrad | X | | X | X | |
| *Monoceros engonatum* Conrad | | | X | | |
| *Murex (Pterohytis) nuttalli* Conrad | X | | | | |
| *Nassa californiana* Conrad | | | X | | |
| *Nassa cerritensis*, sp. nov | | X | | | |
| *Nassa fossata* Gould | | X | X | | |
| *Nassa mendica* Gould | | X | X | | |
| *Nassa mendica* var. *cooperi* Forbes | | | X | | |
| *Nassa perpinguis* Hinds | | X | X | | |
| *Nassa tegula* Reeve | X | X | | | |
| *Neverita recluziana* Petit | | X | X | X | |
| *Norrisia norrisii* Sowerby | | | X | | |
| *Nucula suprastriata* Carpenter | | X | | | |
| *Ocinebra interfossa* Carpenter | | | X | | |
| *Ocinebra lurida* Middendorf | | | X | | |
| *Ocinebra poulsoni* Nuttall | X | | | | |
| *Ocinebra perita* Hinds | | | X | | |
| *Odostomia nuciformis* var. *avellana* Carpenter | | X | | | |
| *Odostomia tenuis* Carpenter | | X | | | |
| *Olivella biplicata* Sowerby | | X | X | | |
| *Olivella intorta* Carpenter | X | | X | | |

| | Pleistocene. | | | Pliocene. | |
|---|---|---|---|---|---|
| | Foot of 26th street. | Spanish Bight. | Pacific Beach. | Pacific Beach. | Russ School. |
| *Olivella pedroana* Conrad | | X | X | | |
| *Opalia anomala* Stearns | | | | X | |
| *Opalia varicostata* Stearns | | | | X | |
| *Ostrea lurida* Carpenter | X | | X | | |
| *Ostrea veatchi* (?) Gabb | | | | X | X |
| *Pecten expansus* Dall | | | | X | |
| *Pecten hastatus* Sowerby | | | | X | |
| *Pecten hemphilli* Dall | | | | X | X |
| *Pecten hericeus* Gould | | | | X | |
| *Pecten latiauritus* Conrad | X | X | | | |
| *Pecten latiauritus* var. *monotimeris* Conrad | | X | | | |
| *Pecten opuntia* Dall | | | | X | |
| *Pecten stearnsii* Dall | | | | X | |
| *Pecten subventricosus* Dall | | | | X | |
| *Pecten ventricosus* Sowerby | X | | | | |
| *Periploma argentaria* Conrad | X | X | | | |
| *Petricola carditoides* Conrad | | X | | | |
| *Phasianella compta* Gould | X | | | | |
| *Pisania fortis* Carpenter | | | X | | |
| *Pleurotoma carpenteriana* Gabb | | | X | | |
| *Pododesmus macroschisma* Deshayes | | | | X | |
| *Pomaulax undosus* Wood | | | X | | |
| *Pteronotus festivus* Hinds | | X | | | |
| *Purpura crispata* Chemnitz | | | | X | X |
| *Ranella californica* Hinds | | | X | | |
| *Saxidomus aratus* Gould | X | | | | |
| *Scala crebricostata* Carpenter | X | | | | |
| *Scala tincta* Carpenter | X | | X | X | X |
| *Semele decisa* Conrad | X | | | | |
| *Semele pulchra* Sowerby | X | | | | |
| *Serpulorbis squamigerus* Carpenter | | | X | | |
| *Siliqua lucida* Conrad | X | X | | | |
| *Siliqua patula* var. *nuttalli* Conrad | | X | | | |
| *Siphonalia kellettii* Forbes | | | X | | |
| *Solen rosaceus* Carpenter | | X | | | |
| *Strongylocentrotus purpuratus* | | X | | X | |
| *Tagelus californianus* Conrad | X | | | | |
| *Tapes staminea* Conrad | X | X | | X | X |

| | Pleistocene. | | | Pliocene. | |
|---|---|---|---|---|---|
| | Foot of 26th street. | Spanish Bight. | Pacific Beach. | Pacific Beach. | Russ School. |
| *Tapes tenerrima* Carpenter | | X | | | |
| *Tellina bodegensis* Hinds | | X | | | |
| *Terebra simplex* Carpenter | X | X | X | | |
| *Tivela crassatelloides* Conrad | X | X | | | |
| *Tornatina cerealis* Gould | | X | | | |
| *Tornatina culcitella* Gould | X | X | | | |
| *Tornatina harpa* Dall | | X | | | |
| *Tresus nuttalli* Conrad | | X | | | |
| *Turritella cooperi* Carpenter | | | X | X | X |
| *Turbonilla* (four species) | | X | | | |
| *Vitrinella*, sp. indet | | X | | | |
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| *Volvarina varia* Sowerby | X | | | | |
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# CHAPTER III.

## FAUNAL RELATIONS.

### 1. PLIOCENE.

The fauna of the Deadman Island Pliocene strata is somewhat similar to the fauna which is now living in the waters only a short distance offshore from San Pedro. Dredging[1] has shown this, and has also shown that the sediments now being deposited off San Pedro are similar to those which make the strata of the Deadman Island and Timm's Point Pliocene. The Pliocene strata consist for the most part of rather fine clayey brown sand which has its counterpart in the fine sand and mud now being deposited off shore from San Pedro. The Pliocene fauna, although quite similar to the fauna now living off San Pedro, still has many species which are found living only north of that place. To state it more precisely, 18.5 per cent. of the species found in the Deadman Island Pliocene fauna are found living now only to the north of San Pedro. Many of these northern species are limited in range to the boreal waters north of the Puget Sound district. The occurrence in large numbers in the Deadman Island Pliocene of *Pecten caurinus*, *Panomya ampla*, *Thyasira bisecta*, *Pecten hericeus*, *Lucina acutilineata*, *Natica clausa*, several species of *Trophon*, and other boreal and subboreal forms, leads to the conclusion that the strata in which they occur were deposited in water probably much colder than that which is found off shore from San Pedro at the present time. The species found fossil in the Deadman Island Pliocene, and still living at San Pedro, also offer evidence of the northern climatic conditions during later Pliocene times. Of the species living at San Pedro at the present time, and found fossil in the Pliocene, nearly all are more common toward the north. In fact, San Pedro is the southern limit of the known range of many of the species. Boreal or subboreal conditions so near the shore imply more or less similar climatic conditions on the land, at least near the ocean. This being the case, it is more than probable that during the latter part of the Pliocene epoch the climate was much colder on the coast of Southern California than it is at the present time.

[1] During the summer of 1901 dredging was carried on in the waters adjacent to San Pedro, Catalina Island, and San Diego, by a party of zoologists under the supervision of Dr. W. E. Ritter, of the University of California. The information obtained by the party was very important, and that regarding the mollusca was especially so to the conchologists and palæontologists of this coast, as it extended the known southern range of many species heretofore known only north of San Pedro. To Professor Raymond, who had charge of the mollusca obtained, and to Mrs. Oldroyd, who assisted in the classification of the same, the writer is indebted for much of the information regarding the offshore fauna near San Pedro.

## 2. Pleistocene.

*The Lower San Pedro Series.*—The lower San Pedro strata of Deadman Island and the San Pedro bluffs were deposited in water shallower than that in which most of the underlying Pliocene strata were laid down. The sediments and fauna of the lower San Pedro deposits show this. The sediments consist for the most part of medium grained gray sands such as are being deposited at the present time in about ten to twenty fathoms of water off the San Pedro shore-line. The occurrence in the lower San Pedro deposits of many species which live only between tides also offers evidence of their close in-shore deposition. The fauna of the lower San Pedro series is one of transition between the boreal or subboreal fauna of the later Pliocene and the semitropical fauna of the upper San Pedro series. Two causes account for this. First, the deposits being laid down in shallower water than that in which the Pliocene sediments were deposited would necessarily contain fewer of the colder, deeper water forms of the Pliocene; and second, the cold climatic conditions prevalent during the later Pliocene epoch were giving place to a warmer climate, which had its effect upon the boreal species which inhabited the water off San Pedro during Pliocene times.

The species found in the lower San Pedro deposits and now found living only north of San Pedro comprise 17.4 per cent. of the lower San Pedro fauna. This percentage is only a little lower than that of the northern species found in the Pliocene (the latter being 18.5 per cent.), and shows, considering the fact that the lower San Pedro beds were deposited in shallower water than that in which the Pliocene was laid down, that the climatic conditions had changed but little during the period intervening between the deposition of the Pliocene and lower San Pedro series. The evidence offered by several species (3.4 per cent. of the entire lower San Pedro fauna) which are found in the lower San Pedro series, but are now found living only south of San Pedro, shows, however, that the conditions of temperature were changing.

Besides the distinctly northern forms which either disappear or become scarce in the period between the Pliocene and lower San Pedro series, there are many species best suited for northern conditions which become rare in the lower San Pedro series, while species best suited for southern conditions begin to increase in numbers. All of the evidence shows that climatic conditions were changing from boreal towards tropical during the time of the deposition of the lower San Pedro series. That the boreal conditions still preponderated during this period, however, is shown by the fauna of the lower San Pedro.

*The Upper San Pedro Series.*—The deposits of the upper San Pedro series consist of coarse gravels, and sands which show alternating dune and water bedding; and the rapidly changing conditions under which the deposits were laid down is evidenced by their variation. The fauna of the upper San Pedro series is southern in character, and, as would be expected, approaches more nearly the present living fauna of the San Pedro region. Being deposited in shallower water than either the Pliocene or lower San Pedro deposits, one would expect it to contain fewer of the cold water species and more of the species found only between tides and in the warm

waters of the lagoons. Such is the case, but it is a noticeable fact that in the upper San Pedro fauna 14.2 per cent. are species which are found living at the present time only south of San Pedro. Not only is this true, but of the species in the upper San Pedro fauna which are now living at San Pedro a large number are best suited for southern conditions.

Although 6.1 per cent. of the upper San Pedro fauna are found now living only north of San Pedro, these northern species are only very rarely found in the upper San Pedro deposits. On the other hand, not only are most of the southern forms common in the upper San Pedro series, but the whole fauna has a semitropical aspect. Such species as *Cardium elatum*, *Arca labiata*, *Pecten dentatus*, *Mactra exoleta*, *Venus gnidia*, *Murex leeanus*, *Eupleura muriciformis*, *Cancellaria tritonidea*, and *Bulla punctulata* give this fauna its tropical character. The evidence offered by the southern forms outweighs the evidence of the northern species in another respect, for it would require a great change in climate from the conditions prevalent during later Pliocene times to cause these southern species to migrate northward to the San Pedro region; while this same change in climate would not so visibly affect the northern species, for they could simply migrate into deep water, where the conditions would more nearly approximate the boreal. This latter has been the case with such species as *Lucina acutilineata*, *Chrysodomus tabulatus*, *Solariella cidaris* and *Solariella peramabilis*, which now inhabit northern waters, near shore, but which have been dredged in the deep water between Catalina Island and the mainland.

The evidence offered by the upper San Pedro fauna leads to the conclusion that semitropical conditions prevailed during the deposition of this formation. The similarity of the fauna of these beds with that now living at San Pedro and the adjacent coast makes it probable that the conditions, although more tropical than those of the present time, were not extremely tropical.

### 3. Relation of the Late Pliocene, Pleistocene, and Living Faunas of California to the Fauna of Japan.

Great similarity exists between the late Tertiary and Pleistocene marine invertebrate fauna of Japan and that of the western coast of the United States. This similarity is shown by a comparison of the species found in the uppermost Tertiary deposits in the region about Tokio and the species found in beds of similar age along the Pacific coast of North America.

Dr. Brauns[1] has described some of the formations in the vicinity of Tokio, and has given lists and descriptions of the fossils found in these formations. Dr. Brauns thinks that the deposits he has examined are of the uppermost Tertiary. His lists of fossils lead to that conclusion, if one compares them with the fauna of the later Pliocene of California. Many of the Japanese species have counterparts in species found in the San Pedro deposits. Such species, for example, as *Lucina borealis*, *Cylichna cylindracea*, and *Pecten yessoensis* are closely related, if not identical, with the west

[1] Geology of the Environs of Tokio. By David Brauns. Mem. Sci. Dept. Univ. of Tokio, No. 4, 1881, pp. 27, 51.

American species, *Lucina acutilineata, Cylichna alba, and Pecten caurinus.* There are many such cases of the similarity of species, and in a few instances identical species have been found which are common to the two regions. The following species are found in Dr. Brauns' list of upper Tertiary fossils from Ojai, near Tokio, which are also found in the San Pedro deposits:

LIST OF FOSSILS FROM OJAI, WHICH ARE FOUND IN THE SAN PEDRO DEPOSITS.

| | | |
|---|---|---|
| *Cardium californiense* [= *C. corbis*] | *Kellia suborbicularis* | *Panopea generosa* |
| *Crepidula aculeata* | *Macoma nasuta* | *Tresus nuttalli* |

Among the species now found living in Japan, and on the west American coast, and also found in the San Pedro deposits, are the following:[1]

LIST OF LIVING SPECIES COMMON TO JAPAN AND THE WEST COAST OF NORTH AMERICA, WHICH ARE FOUND IN THE SAN PEDRO DEPOSITS.

| | | |
|---|---|---|
| *Cardium corbis* | *Macoma nasuta* | *Sanguinolaria nuttalli* |
| *Crepidula grandis* | *Macoma secta* | *Siphonalia kellettii* |
| *Cryptochiton stelleri* | *Mytilus edulis* | *Tresus nuttalli* |
| *Dentalium hexagonum* | *Natica clausa* | *Tapes staminea* |
| *Drillia inermis* | *Pecten hericeus* | *Tellina bodegensis* |
| *Leptothyra carpenteri* | *Purpura crispata* | *Tritonium (= Priene) oregonensis* |
| *Macoma edulis* | *Panopea generosa* | *Trophon orpheus (= T. stuarti (?))* |
| *Macoma inquinata* | *Pododesmus macroschisma* | |

The living faunas of the Japanese and west American coasts, though having many species in common, are not as closely related as are the upper Tertiary and Pleistocene faunas of the same regions. This has been brought about in two ways. First, the more or less close connection between the two regions, which existed in late Tertiary and early Pleistocene times, has been broken; and second, southern species from the warm China seas have migrated northward and mingled with the Japanese early Pleistocene species, while Panama species have come northward during the upper San Pedro time and changed the aspect of the fauna of the west coast of North America. Those species which Japan and the west coast of North America have in common are either circumboreal or are forms which have changed little since the habitats of the two faunas were similar and connected; those species which differ but slightly have in many cases made this change since the connection was broken; and many of the forms which occur in each fauna, and which have no counterpart in the other, have come into these faunas in comparatively recent times.

An interesting example of the migration which took place between Japan and western North America is offered by the genus *Haliotis.* This genus is of Asiatic origin, but it migrated to the northern American coast during late Pliocene or early Pleistocene times. This is shown by the absence of this species from any of the pre-Pleistocene formations along this coast. Only two fossil *Haliotidæ* have been found on this coast, one being taken from the upper San Pedro (Pleistocene) gravel of

[1] This list is compiled from the following papers:
Mollusks of Western North America. By P. P. Carpenter. Smithsonian Miscellaneous Collections, No. 252, 1872.
Catalogue of California Fossils. By J. G. Cooper. 7th Ann. Rept. Cal. State Mineralogist, 1888.

Deadman Island, and the other from the Pleistocene (upper San Pedro series) at Spanish Bight, San Diego. The nearly total absence of this species from even the Pleistocene deposits is accounted for by the length of time it would take the species to migrate to the California coast from Alaskan waters, where it first reached the American shore during Pliocene or early Pleistocene times. This scarcity of the *Haliotidæ*, which are so common in the living fauna, in even the upper San Pedro deposits, is more evidence in favor of the theory that a long period of time has elapsed since the deposition of the upper San Pedro series.

Dr. J. P. Smith explains the phenomena of the similarity of the late Tertiary and early Pleistocene fauna, and the somewhat similar, though diverging, living faunas in this way: during Tertiary time there was an elevation of the submarine shelf which follows the line of the Aleutian Islands. This elevation made possible the intermigration of many species which otherwise never could have crossed the abyssal gap which now separates the northwestern American and Japanese regions. After the elevation of this shelf it remained in a more or less constant position for some time, and then became deeply submerged again, with a consequent breaking of the faunal connection between the two regions.

From the evidence brought forward in this paper, it has been seen that the late Pliocene and early Pleistocene was a period of the southward extension of boreal conditions on the west American coast; it would, therefore, be natural to infer that approximately the same conditions prevalent on the Californian coast during late Pliocene times also prevailed along the Japanese coasts during the same period. A detailed study of the Tertiary and Pleistocene deposits of Japan is awaited with interest, as such a study will throw more light on the conditions prevailing on the shores of the North Pacific during the later geologic epochs.

# PART II. DESCRIPTIONS OF SPECIES.

## THE PLIOCENE AND PLEISTOCENE FAUNA OF SAN PEDRO AND VICINITY.

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# CŒLENTERATA.[1]

## Class ANTHOZOA.[2]

### Family I. TURBINOLIDÆ.

### Genus **Caryophyllia** *Lamarck.*

#### 1. **Caryophyllia arnoldi** *Vaughan.*

PLATE III, FIGS. 4 AND 4*a*.

*Caryophyllia arnoldi* VAUGHAN, Proc. U. S. Nat. Mus., Vol. XXII, 1900, No. 1194, pp. 199, 200, Pl. XVI, figs. 1, 2.

The following is the original description:—

Form of corallum slightly deformed inverted cone-shaped. A basal scar present, but the coral in its later stages was evidently unattached. Base subacute, calice nearly circular in transverse outline.

Costæ very distinct, low, broad, rounded, or flattish, show no ornamentation, but the specimen is worn, and they were probably minutely granulated, There is a tendency to alternation in size, which is pronounced near the base. There is no observable epitheca. The wall is stout, solid, a distinct pseudotheca. The costæ are wide and the intercostal spaces very narrow, simply furrows, and the septa are thickened at the wall. The upper margins of the septa project very slightly above the upper limit of the corallum wall. There are four complete cycles of septa (forty-eight in all), arranged as follows: Twelve large thick septa, joined to the columella by very thick pali. The width of each palus is equal to the width of its corresponding septum; the upper margins of the palus stand about 2 mm. above the upper surface of the columella, and fully 1 mm. above the notch dividing the palus from the septal lamina. The width of the pali is about 2.5 mm. From the upper margin of the septum to the notch between septum and palus is about 4.5 mm., may be slightly greater. The inner ends of the pali are fused solidly around the columella and to it. On the septal faces are small granulations arranged in curves parallel to the upper septal margins. On the faces of the pali are granulated or serrated crests arranged in curves parallel to the upper margins of the pali. Between each pair of these larger septa are three smaller (one of the third cycle and two of the fourth). The members of the third cycle are narrow above the level of the upper termination of the columella; below this they widen, but do not seem ever to reach the columella. The members of the fourth cycle are narrow, and thin except where they arch over the walls. The columella is essential, is composed of several pieces, trabeculæ, which are firmly soldered one to another and to the inner terminations of the pali by solid basal calcareous deposit. From the upper margins of the septa to the upper termination of the columella is about 6.5 mm.; that is, the calicular fossa is about 6.5 mm. deep. The greater diameter of the upper termination is 5 mm., the lesser 3.5 mm., above whose level, as may be gathered from what preceded, the pali form a regular crown.

*Dimensions.*—Greater diameter of calice, 16 mm.; lesser diameter of calice, 15.3 mm.; height of corallum, 16.5 mm.; depth of fossa, about 6.5 mm.

*Locality.*—San Pedro Hill, San Pedro, California.

*Geologic Horizon.*—Pleistocene.

*Type.*—Cat. No. 157,509, U. S. National Museum.

---

[1] The general arrangement of the classes is that used by Eastman in Zittel's Text-Book of Paleontology.

[2] Mr. Wayland Vaughan, of the United States Geological Survey, has prepared the diagnoses of the new Anthozoa which have been found in the San Pedro deposits. These descriptions are here included in this paper.

### 2. Caryophyllia pedroënsis *Vaughan*, sp. nov.

PLATE III, FIGS. 3 AND 3*a*.

Corallum cornute, transverse calicular outline broadly elliptical.

The outer surface of the specimen is worn, so that the detail of the ornamentation is destroyed, but it can be discovered that the costæ were not very prominent, and that there were twelve corresponding to twelve large septa, pronouncedly larger than the others.

The septa are in four complete cycles; the members of the first and second cycles reach the columella and are rather thick, especially around the columella; those of the third are shorter and thinner, and those of the fourth still smaller. The septa are not so thick as in *C. arnoldi*, and not so crowded as in *C. californica*. The septal faces are granulated, the granulations being much larger and with blunt ends near the columella. All the pali except one are broken off, but they appeared to exist before the twelve larger septa. The one remaining palus is broad and thin.

Calice fairly deep. Upper surface of the columella not very deeply sunken below the level of the upper edge of the pali. Columella composed of several twisted pieces.

*Dimensions.*—Greater diameter of calice, 13.5 mm.; lesser diameter of calice, 12 mm.; height of corallum, 25.5 mm.

*Locality.*—San Pedro, California.

*Geologic Horizon.*—Pleistocene.

*Type.*—From the collection of Ralph Arnold.

### 3. Caryophyllia californica *Vaughan*, sp. nov.

PLATE III, FIGS. 2 AND 2*a*.

Corallum with a narrow base, the lower half slender in comparison with the diameters at the calice. The tip of the base damaged. Calice elliptical in transverse outline.

The outer surface of the corallum is scarcely costate. There are flat, indistinct, densely granulate costæ corresponding to the septa, visible especially at and just below the calicular edge. The wall is thin and fragile.

There are four complete cycles of septa and many members of the fifth. They are thin and crowded, twelve are larger than the others, and apparently these twelve bore pali on their inner terminations. The margins of the septa of the first and second cycles project slightly above the upper edge of the wall, about 1 mm.; the margins of the septa of the other cycles are not prominent. The septal faces are granulated, the granulations are low, frequently showing elongation along the courses of the septal trabeculæ; the usual arrangement in curves parallel to the septal margins also is shown. Calice fairly deep, 4.5 or 5 mm.; a distinct and rather sudden depression over the columella. Columella not greatly developed, composed of a few loosely twisted laths.

*Dimensions.*—Greater diameter of calice, 11.5 mm.; lesser diameter of calice, 10 mm.; height of corallum, 13 mm.

*Locality.*—Deadman Island, off San Pedro, California.

*Geologic Horizon.*—Pliocene.

*Type.*—From material sent by Mr. Ralph Arnold to the U. S. National Museum.

DIFFERENTIAL CHARACTERS OF THE THREE CALIFORNIAN SPECIES OF CARYOPHYLLIA.

| | | |
|---|---|---|
| Septa in four cycles | form cornute; twelve more prominent costæ | *C. pedroënsis* |
| | form short, inversely subconical, costæ equal near the calice, alternating in size near base | *C. arnoldi* |
| Septa in four complete cycles, many members of the fifth present | form subflabellate, costæ excepting near the calicular margin indistinct | *C. californica* |

As the descriptions and the above table show, for the differentiation of the species, especial stress is laid upon the number of the septa, the form, and the costal characters. Although each of the three species is based on a single specimen, the author does not believe it possible for intergradation to occur within the horizons from which they were collected. *C. pedroënsis* and *C. arnoldi* appear to belong in the same group (section) of the genus; but *C. californica* presents great and striking differences from each of the preceding.

## Genus **Paracyathus** *Milne-Edwards & Haime.*

Verrill has described three species of *Paracyathus* from the west coast of North America, viz.: *Paracyathus caltha*,[1] *Paracyathus stearnsi*,[2] and *Paracyathus humilis*.[3] The first two species mentioned are from Monterey, California; the last mentioned is from the Pearl Islands.

Expressed in tabular form the differences between these three species are:—

| | | |
|---|---|---|
| Corallum .5 in.[4] or more in height; five complete cycles of septa | Costæ distinct only at edge of calice, below represented by rows of grannles; axes of calice, .45 in./.32 in. | *P. caltha* |
| | Scabrous, subequal costæ, distinct to base, near base every fourth or sixth costa more prominent; axes of calice, .72 in./.50 in. | *P. stearnsi* |
| Corallum only .2 in. in height; four complete cycles of septa. | Costæ feeble, except near calicular margin. Diameter of circular calice, .22 in. | *P. humilis* |

According to the diagnostic characters given by Verrill, these three species are very distinct.

### 4. **Paracyathus pedroënsis** *Vaughan*, sp. nov.

PLATE III, FIGS. 1 AND 1*a*.

Corallum subturbinate in shape, base damaged, apparently not especially expanded; transverse outline of calice elliptical, slightly deformed.

Costæ not prominent, but distinct from the calicular margin to the base, subequal, sometimes every third or every fifth may be slightly more prominent than those intervening, the edges usually flattish, sometimes slightly crested. Bottoms of the intercostal furrows usually flattish; granulations crowded on the costæ, and present in the intercostal furrows also.

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[1] Proc. Bost. Soc. Nat. Hist., Vol. XII, 1869, p. 394; Trans. Conn. Acad. Sci., Vol. I, 1870, p. 537, Pl. IX, figs. 9, 9A.

[2] Proc. Bost. Soc. Nat. Hist., Vol. XII, 1869, p. 393; Trans. Conn. Acad. Sci., Vol. I, 1870, p. 537.

[3] Trans. Conn. Acad. Sci., Vol. I, 1870, p. 538.

[4] These decimals of an inch can be computed into millimetere by reckoning .1 inch = 2.5 mm.

There are four complete cycles of septa, and many members of the fifth, but the fifth is not complete. The septal margins project very slightly above the upper margin of the corallum wall; the margins of the members of the first and second cycles, and those of the third cycle when members of the fifth are present, are slightly more prominent than the margins of the members of the higher cycles. The septal faces are densely granulated, and the granulations show a decided tendency toward elongation along the courses of the septal trabeculæ. The septa are crowded, those of the first, second, and third cycles are thick and strong; when members of the fifth cycle are present those of the fourth are quite thick, but are thinner than the older septa.

The pali are well developed, and are shown in great perfection on the type specimen. They are broad and simple, and not bilobed. Those before the septa of the first cycle are the narrowest; those before the septa of the second cycle are slightly wider, and those before the septa of the third cycle are still wider. The inner margins of the pali before the septa of the first, second, and third cycles form a crown bordering the outer edge of the columella. In those half or quarter systems in which septa of the fifth cycle are present, pali stand before the members of the fourth cycle. These pali are large, but stand back from the columella. In such cases the pali join the members of the fourth cycle to the sides of the included members of the third. When no pali are present the members of the fourth fuse by their inner margins directly to the side of the included member of the third. When members of the fifth cycle are present, they curve toward the included member of the fourth. There are no pali before the youngest septa in any given system. Margins of the pali entire.

The calice is shallow, widely open. Its ends, corresponding to the ends of the longer transverse axis, are very slightly depressed. The upper surface of the columella is flat; it consists of the rounded upper terminations of a large number of papillæ. The pali, excepting those of the fourth cycle, form a crown around the columella, as has already been stated.

*Dimensions.*—Greater diameter of calice, 12 mm.; lesser diameter of calice, 10 mm.; height of corallum, 18+ mm.

*Locality.*—San Pedro, California.

*Geologic Horizon.*—Pleistocene.

*Type.*—From the collection of Ralph Arnold.

If the description first given is compared with the table showing the chief diagnostic features of Verrill's species, it will be evident that the only species with which comparison needs to be made is *P. stearnsi.* At the same time, certain striking differences between the two will be very evident. The first is one of size.

| | Greater Diameter of Calice. | Lesaer Diameter of Calice. | Height of Corallum. |
|---|---|---|---|
| *P. stearnsi*..... | 18 mm. | 12.5 mm. | 12.5 mm. |
| *P. pedroënsis*..... | 12 mm. | 10 mm. | 18+ mm. |

The costæ and the number of septa are different in the two species, but a much more important difference has not yet been brought out in the discussion. Verrill says of the septa and pali in *P. stearnsi:* "The primary and secondary septa are considerably broader than the others, broadly rounded and somewhat exsert at summit, narrowed toward the base, and *divided into two or three unequal, broad, stout, paliform teeth,* which are rough and lacerately spinulose at summit. . . . . ."[1]

[1] The italics are used by the author of the present paper.

As stated in the present description, the pali of *P. pedroënsis* are *not lobed and their margins are entire.*

These comparisons will show how strikingly different the present species is from any of those previously described species from the west coast of North America.

# ECHINODERMATA.

## Class ECHINOIDEA.[1]

## Subclass EUECHINOIDEA.

### Order DIADEMATOIDA.

### Suborder STEREOSOMATA.

### Family II. ECHINOMETRIDÆ.

### Genus **Strongylocentrotus** *Brandt.*

Test symmetrical and polyporus. Amb straight, broad at the ambitus and peristome, and with broad, poriferous zones. Pairs of pores in oblique arcs, or almost transverse series of from four to ten pairs, and crowded actinally. Interporiferous areas with two vertical rows of plain, imperforate primary tubercles; secondaries and miliaries also present. Amb with two rows of primary, and four or more of secondary tubercles.

#### 5. **Strongylocentrotus franciscanus** *A. Agassiz.*

*Toxocidaris franciscana* A. AGASSIZ, Bull. Mus. Comp. Zool., Vol. 1, 1863 (*fide* Clark.)

This is the large sea-urchin of the West Coast. Spines which are probably of this species have been found in the lower San Pedro series of Deadman Island. The spines of this species are distinguishable by their large size and longitudinal striations. Some of the spines found are 20 mm. long and 3 mm. in diameter.

*Living.*—Puget Sound; San Diego (H. L. Clark).

*Pleistocene.*—San Pedro (Arnold).

#### 6. **Strongylocentrotus purpuratus** *Stimpson.*

*Echinus purpuratus* STIMPSON, Crustacea and Echinoderms of the Pacific Coast, 1857 (*fide* CLARK.)

Numerous spines of this small purple sea-urchin have been found in the San Pedro series. No part of the test has ever been discovered in these deposits, to the writer's knowledge. Several nearly perfect tests of this species were found in the

[1] The classification and generic descriptions for this class are from Eastman in Zittel's Text Book of Paleontology.

Pleistocene (lower San Pedro series) deposits at the bath-house, Santa Barbara. A nearly perfect test was also found in the upper horizon of the San Diego formation (Pleistocene(?) at Pacific Beach, near San Diego.

*Living.*—San Francisco; Puget Sound (H. L. Clark): San Pedro (Arnold).

*Pleistocene.*—San Pedro; Santa Barbara; San Diego (Arnold).

## Order CLYPEASTROIDA.

### Family III. SCUTELLIDÆ.

#### Genus **Scutella** *Lamarck.*

Test circular or subcircular in outline, sometimes undulating or notched, broadest behind; petaloid parts of the amb unequal, well developed, nearly closed. Peristome small, central, subcircular. Periproct very small, inframarginal. Apical system central, more or less pentagonal.

#### Subgenus **Echinarachnius** *Leske.*

Apical system eccentric in front or behind. Periproct actinal, marginal or supramarginal.

##### 7. **Scutella (Echinarachnius) excentricus** *Eschscholtz.*

*Scutella excentrica* ESCH., Zool. Atlas, Pl. XX, fig. 2, 1826.

*Echinarachnius excentricus* ESCH., Valenciennes, Voyage Venus, Pl. X, 1846;=*Scutella striatula* CON. (*fide* COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 271). MERRIAM, Bull. Dept. Geol., Univ. of Cal., Vol. II, 1898, p. 110; Proc. Cal. Acad. Sci., 3rd Ser., Geol., Vol. I, 1899, p. 170, Pl. XXII, fig. 8.

Test quadrate-oval in outline; upper surface arched, summit behind the middle of the long diameter, but in front of the excentric apical system; petals broad, open at ends; posterior laterals wide apart, ovate in outline, one-half the length of the anterior pair; anterior petal longer than the anterior laterals, scattered pores continue some distance beyond the end; apical shield excentric, its distance from the posterior margin being to its distance from the anterior margin as 1 to 1.8+; the ambulacral furrows are split up into a great number of small branches, of which the strongest pass over the margins and extend over the upper surface; four of the strongest furrows run to the lateral petals and stretch through their median areas almost to the apical system; those furrows not passing to the petals sometimes reach half way to the apical system.

*Dimensions.*—Long. 63 mm.; lat. 68 mm.; alt. 8 mm.

Specimens from the lower San Pedro series of Deadman Island, and upper San Pedro series of San Pedro and Los Cerritos were submitted to Dr. Merriam, who pronounced them typical *E. excentricus.* This is the common "Sand Dollar" of the Pacific Coast.

*Living.*—Alaska to San Pedro (Cooper).

*Pleistocene.*—San Pedro (Cooper; Arnold): San Diego; Santa Barbara (Arnold)

*(?) Pliocene.*—Seven Mile Beach, San Mateo County; San Fernando; (?) San Diego (Cooper): (?) San Gregorio Creek, San Mateo County (Barber).

# MOLLUSCOIDEA.

## Class BRYOZOA.

### 8. **Bryozoa** sp. indet.

Small pieces of branching bryozoa are found quite abundantly in the San Pedro series; but as no diagnoses of West Coast species are available, their generic and specific relations cannot be given. Among some material sent to Dr. Dall, and identified by him, were several specimens which he labeled "*Cupulifera* sp." These little saucer-shaped bryozoa are from the upper San Pedro deposits, at the lumber-yard, north end of the San Pedro bluff.

## Class BRACHIOPODA.[1]

### Order ARTHROPOMATA.

#### Family IV. TEREBRATULIDÆ.

Genus **Terebratalia** *Beecher.*

Shell smooth or radially plaited; dorsal valve longitudinally impressed; hinge-line straight or not much curved; beak with a flattened area on each side of the deltidium; foramen large; deltidium incomplete; loop attached to the septum.

*Terebratalia obsoleta* Dall is a characteristic species.

[S. B.][2] **Terebratalia hemphilli** *Dall.*

PLATE XVII, FIGS. 1, 2 AND 3.

*Terebratalia hemphilli* DALL (mss.)

Shell of medium size, subcircular in outline, rather thin; brachial valve with mesial flexure concave; surface of this valve sculptured by numerous fine incremental lines, and very faintly near the apex by several radiating lines; pedicle valve mesially convex, the sculpture being as in the brachial valve.

*Dimensions.*—Long. 56 mm.; lat. 57 mm.; diam. 30 mm.

This species may be distinguished from *T. smithi* by its broader outline, larger foramen, and nearly smooth surface. *T. hemphilli* is a form which shows much variation both as regards its outline, degree of convexity or concavity of its valves, and its sculpture. The drawings of this species were made by Mr. J. Howard Wilson, who first discovered the species. Found in the Pliocene of Packard's Hill, Santa Barbara.

*Pliocene.*—Santa Barbara (Wilson; Arnold).

---

[1] The classification and generic description of this class are from Tryon's "Structural and Systematic Conchology."

[2] All species described in this paper, but not occurring in the San Pedro fauna, are designated by the initials of the locality from whence they are described.

### 9. **Terebratalia smithi**, sp. nov.

PLATE XVII, FIG. 9.

Shell of medium size, subcircular in outline, rather thin; brachial valve with mesial flexure concave, surface of this valve sculptured by about thirty small, rounded, radiating ridges and several prominent incremental lines; intermediate incremental lines small and inconspicuous; pedicle valve quite strongly mesially convex, the surface being sculptured as in the dorsal valve; beak with a flattened area on each side of the deltidium; foramen small. At a length of 20 mm. and before, the shell is slightly broader proportionately than in the adult.

*Dimensions.*—Long. 50 mm.; lat. 47 mm.; diam. 23 mm.

*T. smithi* resembles *T. hemphilli* Dall (mss.), but differs from that species by being much narrower in all stages of growth, having a much smaller foramen, and in being much more prominently sculptured. A large series of *T. hemphilli* collected from the Pliocene at Santa Barbara by Mr. J. Howard Wilson was compared with the type of *T. smithi*, and the specimens in every case showed the differences mentioned above. The drawings of *T. hemphilli* (Pl. XVII, figs. 1, 2, 3) were made by Mr. J. Howard Wilson from a specimen obtained at Santa Barbara, and are inserted here for comparison with the figure of the type specimen of *T. smithi*. *T. hemphilli* has been found so far only in the Pliocene of Santa Barbara.

This species and *Laqueus jeffreysi* are the only brachiopods which have so far been found in the San Pedro beds. The type specimen, the only one found, was obtained by Mrs. Oldroyd from the Pliocene of Deadman Island; it is figured in this paper, and is now in the collection of Mrs. Oldroyd.

*Pliocene.*—San Pedro (Oldroyd).

## Genus **Laqueus** *Dall.*

Shell with the reflected portion of the loop attached by slender processes, on each side, to the hæmal processes, at or near the points where the two septal processes branch off to the septum; foramen complete.

Type, *Laqueus californicus* Koch.

### 10. **Laqueus jeffreysi** *Dall.*

*Frenula jeffreysi* DALL, Am. Nat., Vol. V., 1871, p. 55 (ismeniform stage).
*Ismenia jeffreysi* DALL, Am. Jour. Conch., Vol. VII, 1871, p. 65, Pl. XI, figs. 7–10.
*Megerlia jeffreysi* DALL, Sci. Res. Expl. Alaska, 1877, p. 48.
*Laqueus californicus* var. *vancouverensis* DAVIDSON, Mon. Rec. Brachiopoda, Trans. Linn. Soc., 2nd Ser., Vol. IV., 1887, p. 113, Pl. XVIII, figs. 10–13*b* (adult), (*fide* Dall).
*Laqueus jeffreysi* DALL, Proc. U. S. Nat. Mus., Vol. XVII, 1894, p. 725.

Shell subcircular, inflated, with the margins of the valves nearly straight; surface smooth, waxen, with close, conspicuous punctations; area marked by an incised line; deltidia wanting; the two separated parts of the area narrow and very small; beak of the hæmal valve rather prominent, smooth. Neural beak incurved, truncated, not prominent.

*Dimensions.*—Long. 35mm.; lat. 35 mm.; diam. 17 mm.

Distinguishable externally from *L. californicus* by thicker shell, waxen rather than ruddy coloration, and larger foramen. Specimen identified by Dr. Dall. Specimens which may be of this species are labeled "*L. californicus*" in the State Museum collection of fossils at Berkeley. Found in Pliocene of Deadman Island; two specimens, one by Mrs. Oldroyd. Found in Pliocene of Pacific Beach, near San Diego, and also in the Pliocene of Packard's Hill, Santa Barbara.

*Living.*—Aleutian Islands to point off Estero Bay, near San Luis Obispo, (75 to 238 fathoms) Dall.

*Pliocene.*—San Pedro (Arnold; Oldroyd): Santa Barbara; San Diego (Arnold).

## Family V. LINGULIDÆ.

### *Subfamily LINGULINÆ.*

### Genus **Glottidia** *Dall.*

Shell linguiform, elongate, pedunculated; dorsal valve provided internally with two sharp, narrow, incurved laminæ, diverging from the beak, and extending about one-third the length of the shell; ventral valve with a mesial septum of about the same length, extending forward from the beak; anterior adductor impressions rounded; scar of post-adductor close in cavity of beak, rounded; shell smooth, perforate or imperforate.

Type, *Glottidia albida* Hinds.

#### [S. B.] **Glottidia albida** *Hinds.*

*Lingula albida* HINDS, Zool. Sulph., p. 298, Pl. XXIX, fig. 4, 1845. G. W. SOWERBY, Thes. Conch., p. 393, Pl. LVII, fig. 6, 1846. DAVIDSON, Ann. & Mag. Nat. Hist., 2nd Ser., Vol. IX, 1852, p. 377. REEVE, Conch. Icon., Monog. Lingula, Pl. I, fig. 4, 1859. E. SUESS, Sitz. k. Akad. Wiss. Wien, Bd. XXXVII, 1859, p. 230. CARPENTER, Brit. Assn. Rept. 1863, p. 636. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 246. KEEP, West Coast Shells, p. 215, fig. 182, 1892.

*Glottidia albida* HINDS, DALL, Am. Journ. Conch., Vol. VI, 1870, p. 157, Pl. VIII, figs. 1–6; Proc. Phil. Acad. Nat. Sci., 1873, p. 204; Scientific Results Expl. Alaska, 1877. DAVIDSON, Challenger Rept. (Zool.) Vol. I, 1880, p. 26; Recent Brachiopoda, Part 3, 1886, p. 221, Pl. XXVIII, figs. 2–4. WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1893, p. 182.

Shell narrow; elongated, oval, linguiform, tapering at the beaks, sides almost subparallel, very slightly curved in front; rather flat, marked with concentric lines of growth; in interior of ventral valve the beak is pointed, with a small triangular-shaped thickening grooved along the middle; mesial septum extends for one-third length of valve; scars as in generic description.

*Dimensions.*—Long. 27 mm.; lat. 11 mm.; diam. 5.5 mm.

One perfect valve and two imperfect valves of this species were found in the Pliocene of Packard's Hill, Santa Barbara.

*Living.*—Monterey to Magdalena Bay, Lower California (Davidson).

*Pliocene.*—Santa Barbara (Arnold): San Diego well (Hemphill).

# MOLLUSCA.

## Class PELECYPODA.[1]

### Order PRIONODESMACEA.

### Superfamily NUCULACEA.

### Family VI. NUCULIDÆ.

#### Genus **Nucula** *Lamarck.*

Shell trigonal, with the umbones turned towards the short posterior side; smooth or sculptured; epidermis olive; interior pearly; margins crenulated; hinge with prominent internal cartilage-pit, and a series of sharp teeth on each side; pallial line simple.

Type, *Arca nucleus* Lam.

#### Subgenus **Acila** *H. & A. Adams.*

Shell with divaricate sculpture.

*Nucula divaricata* Hinds is a characteristic species.

**11. Nucula (Acila) castrensis** *Hinds.*

*Nucula castrensis* HINDS, Proc. Zool. Soc., 1843, p. 98; Zool. Sulph., p. 61, Pl. XVII, fig. 5, 1844. H. & A. ADAMS, Gen. Rec. Moll., Vol. II, p. 545. WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 192.

*Acila castrensis* HINDS (=*A. lyalli* BAIRD, *fide* CARPENTER, Brit. Assn. Rept., 1863, p. 644); (=*Nucula divaricata* CON.=*N. decisa* CON.=*N. conradi* MEEK, *fide* GABB, Pal. Cal., Vol. II, 1869, p. 102). COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 227. WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 192. DALL, Trans. Wagner Inst. Sci., Vol. III, 1898, p. 572.

Shell small, trigonal, convex, of medium thickness; umbones posterior to center, turned posteriorly; anterior end longer than posterior, rounded; posterior end short, truncated; surface divaricately sculptured; hinge with prominent internal cartilage-pit and numerous sharp teeth on each side.

*Dimensions.*—Long. 11.5 mm.; alt. 10 mm.; diam. 8 mm.

Easily distinguishable by the hinge teeth and divaricate sculpture. Specimens identified by Dr. Dall.

Common in Pliocene, rare in lower San Pedro series, of Deadman Island and San Pedro.

*Living.*—Sitka to San Diego (Cooper).

*Pleistocene.*—Santa Barbara to San Diego (Cooper): San Pedro (Arnold).

*Pliocene.*—San Pedro (Arnold): San Fernando; San Diego well (Cooper).

*(?) Miocene.*—Oregon; Martinez; Griswold's, San Benito County (Cooper): Blakely, near Seattle, Washington (Arnold).

[1] The major classification of this class is according to that presented by Dr. W. H. Dall in Part III of the "Contributions to the Tertiary Fauna of Florida." The minor details of classification and most of the generic descriptions are from Parts IV and V of the same work. The rest of the generic descriptions are from Tryon's "Structural and Systematic Conchology."

### Subgenus **Nucula** *s. s.*

Shell not divaricately sculptured.

*Nucula obliqua* Lam. is a characteristic species.

#### 12. **Nucula (Nucula) suprastriata** *Carpenter.*

PLATE XVIII, FIG. 6.

*(?) Nucula tenuis* (non MONT.) CARPENTER, Brit. Assn. Rept. 1863, p. 644. COOPER, State Mus. Collection Catalogue.

Shell small, trigonal, convex, thin, white, pearly interior; umbones turned toward the short posterior end; posterior end sharply rounded, anterior evenly rounded; surface with numerous distinct, rounded, raised, concentric lines; interior of margin finely crenulated; hinge with small, interior cartilage-pit, and numerous sharp teeth on each side.

*Dimensions.*—Long. 5.8 mm.; alt. 5.2 mm.; diam. 3 mm.

This beautiful little shell is easily distinguishable by its triangular shape, numerous sharp teeth, and distinct concentric sculpture. Specimens identified by Dr. Dall.

Rare in the lower San Pedro series of Deadman Island and San Pedro; and in the upper San Pedro series of San Pedro; common in the upper San Pedro series of Los Cerritos. Found also at Spanish Bight, San Diego. The specimen figured is from the upper San Pedro series at Los Cerritos, and is now in the collection of Delos Arnold.

*(?) Living.*—Straits of Fuca to Santa Barbara; Japan (Cooper).

*Pleistocene.*—San Pedro (Arnold): San Diego (Arnold).

### Family VI. LEDIDÆ.

### Genus **Leda** *Schumacher.*

Shell resembling *Nucula;* oblong, rounded in front, produced and pointed behind; margins even; pallial line with a small sinus; umbonal area with a linear impression joining the anterior adductor.

*Leda pernula* Mull. is a characteristic species.

#### 13. **Leda fossa** *Baird.*

PLATE XVII, FIG. 7.

*Leda fossa* BAIRD, Proc. Zool. Soc., 1863, p. 71. CARPENTER, Brit. Assn. Rept., 1863, p. 644. DALL, Nat. Hist. Soc. British Columbia, Bull, No. 2. 1897, p. 7, Pl. II, figs. 3, 13.

Shell small, elongate, convex, thin; umbones anterior, turning slightly toward the posterior end, which is elongated, narrow and truncated; anterior end short and evenly rounded; sculpture nearly obsolete, a few concentric lines discernible; escutcheon long, narrow, smooth and deep-set; an elongate process on middle of interior of posterior end; hinge with small internal cartilage-pit, and numerous sharp teeth on each side.

*Dimensions.*—Long. 11 mm ; alt. 6 mm.; diam. 3.8 mm.; umbo to posterior end 7.5 mm.; to anterior end 5 mm.

Distinguishable by lack of sculpture. Specimen identified by Dr. Dall.

One specimen from lower San Pedro series of Deadman Island, which is the one figured, and which is now in the collection of Delos Arnold.

*Living.*—Puget Sound (Carpenter).

*Pleistocene.*—San Pedro (Arnold).

### 14. Leda hamata *Carpenter.*

PLATE XVII, FIG. 4.

*Leda hamata* Cpr., Brit. Assn. Rept., 1863, p. 644.

Shell small, elongate-trigonal, convex, thin; umbones anterior, turning slightly toward the posterior end; short, rounded anteriorly; much lengthened, narrowed and abruptly truncated posteriorly; surface sculptured by strong, concentric raised lines; a raised band, strongly transversely sculptured by continuations of the concentric ridges, passes from the umbo, around the escutcheon, to the posterior end; on the interior of the posterior end is an elongated, raised process; escutcheon deep-set, smooth.

*Dimensions.*—Long. 8 mm.; alt. 5 mm.; diam. 2.5 mm.; umbo to posterior end 5.5 mm.; to anterior end 4 mm.

A small species, readily distinguishable by its long, curved posterior portion, strong sculpture, smooth escutcheon, and interior posterior process. Specimen identified by Dr. Dall.

A nearly perfect, united pair from the lower San Pedro series of Deadman Island; rare; also reported from the Pliocene of Deadman Island. Pleistocene of Spanish Bight, San Diego. The specimen figured is from the lower San Pedro series, and is now in the collection of Delos Arnold.

*Living.*—Santa Barbara to Catalina (Carpenter).

*Pleistocene.*—San Pedro (Arnold): San Diego (Arnold).

*Pliocene.*—Deadman Island, San Pedro (Arnold).

### 15. Leda minuta *Fabr.* var. præcursor, var. nov.

PLATE XVII, FIG. 6.

Shell small, trigonal, convex, thin; umbones anterior to middle and turning slightly toward the posterior side; anterior portion from umbones short and rounded; posterior portion longer, slightly depressed, produced and slightly truncated; surface sculptured by prominent, raised concentric lines; escutcheon long, narrow, slightly striated with continuation of concentric ridges; a flat sculptured band runs around escutcheon from umbo to posterior end, and on the interior of the shell at the posterior end of this band is a little elongate ridge or process; hinge with prominent internal cartilage cup and about fifteen prominent sharp teeth on each side; pallial sinus small, narrow.

*Dimensions.*—Long. 7.8 mm.; alt. 5 mm.; diam. 3.9 mm.; umbo to posterior end 5 mm.; to anterior end 4 mm.

Distinguishable from *L. taphria* by smaller size, truncated posterior end with process on interior at this end, comparatively coarser sculpture, straighter posterior dorsal margin, and fewer teeth. The type shows two concentric furrows, one at 2.5 mm. and the other at 4 mm. from the umbo, which are probably the result of interrupted growth. Specimens identified by Dr. Dall, who pronounced them a variety of *L. minuta* Fabr., a northern species.

Rare in lower San Pedro series of Deadman Island and San Pedro. The specimen figured is the type, which is from the lower San Pedro series at Deadman Island, and is now in the United States National Museum.

*Pleistocene.*—San Pedro (Arnold).

### 16. Leda taphria *Dall.*

PLATE XVII, FIG. 5.

*Leda taphria* DALL, Nat. Hist. Soc. British Columbia, Bull. No. 2, 1897, p. 7, Pl. II, figs. 6 and 8 (=*cælata* HDS., 1844, not CONR., 1832; *fide* DALL, Trans. Wagner Inst. Sci., Vol. III, 1898, p. 579).

*Nucula cælata* HDS., Proc. Zool. Soc., 1844, p. 99; Zool. Sulph., p. 64, Pl. XVIII, fig. 13, 1844.

*Leda cælata* HDS., Thes. Conch., Vol. III, No. 42, figs. 95, 96. CARPENTER, Brit. Assn. Rept., 1863, p. 644. GABB, Pal. Cal., Vol. II, 1869, p. 103. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 245. WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 192.

Shell small, trigonal, oblong and rounded in front, produced and pointed behind; surface sculptured by numerous sharp, concentric, raised lines; umbones central, turned toward posterior end; escutcheon long, narrow and concentrically striated; hinge with prominent internal cartilage-pit, and about twenty sharp teeth on each side; pallial line with a small sinus; umbonal area with a linear impression joining the anterior adductor.

*Dimensions.*—Long. 19 mm.; alt. 11 mm.; diam. 8 mm.

This is the largest of this genus found in these deposits, and is easily recognized by its size, sculpture and peculiar teeth. Hinds' name, *L. cælata*, was preoccupied by a species of Conrad's, and Dall has renamed Hinds' species for that reason. Specimens identified by Dr. Dall.

Found in Pliocene of Deadman Island and Timm's Point; lower San Pedro series of Deadman Island and San Pedro; and in the upper San Pedro series of Deadman Island, San Pedro, Crawfish George's, Los Cerritos, and Long Beach. Found also in the Pliocene of Pacific Beach, and in the Pleistocene of Spanish Bight and Pacific Beach, San Diego. The specimen figured is from the lower San Pedro series at Deadman Island, and is now in the collection of Delos Arnold.

*Living.*—Bodega Bay to San Diego (Cooper).

*Pleistocene.*—Santa Barbara to San Diego (Cooper): San Pedro; San Diego (Arnold).

*Pliocene.*—San Fernando; San Diego well (Cooper): San Pedro; San Diego (Arnold).

*Miocene.*—Walnut Creek, Contra Costa County; Griswold's, San Benito County; San Juan Capistrano, San Diego County (Cooper).

### Genus **Yoldia** *Möller.*

Shell oblong, slightly attenuated behind; compressed, gaping, smooth or obliquely sculptured, with a dark olive, shining epidermis; external ligament slight; cartilage as in *Leda;* pallial sinus deep.

*Yoldia myalis* Couth. is a characteristic species.

### 17. Yoldia cooperi *Gabb.*

*Yoldia cooperi* GABB, Proc. Cal. Acad. Sci., Vol. III, 1865, p. 189; Pal. Cal., Vol. II, 1869, p. 31, Pl. IX, fig. 54. WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 192. DALL, Trans. Wagner Inst. Sci., Vol. III, 1898, p. 594.

*Yoldia impressa* (not of CON., Wilkes Exped., Vol. X, p. 726, Pl. XVIII, fig. 13; nor of MEEK, Smithsonian Check-List, Mioc.); in part, GABB, Pal. Cal., Vol. II, 1869, p. 59; in part, COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 270.

Shell of medium size, oblong, pointed at one end, subcompressed, thin; surface ornamented by numerous small, concentric ribs, abrupt on the upper side, and sloping downward on the side towards the base; beaks minute, placed in advance of middle; anterior end narrow, subacuminate; concave above; posterior end broadly rounded; lunule long, narrow, deeply impressed, smooth; hinge with prominent cup-shaped cartilage-pit, with about twelve sharp teeth in front, and about fifty behind; pallial sinus large, deep and rounded.

*Dimensions.*—Long. 64 mm.: alt. 32 mm.; diam. 10.5 mm.; umbo to anterior end 22 mm., to posterior end 44 mm.

The largest of the Nuculidæ found in these deposits; easily distinguishable by its size, peculiar shape, and teeth. One imperfect specimen measured 83 mm. in length. The Miocene form *(Y. impressa)* is much smaller and less compressed. Specimens identified by Dr. Dall.

Rare in upper San Pedro series of San Pedro; three specimens. Found also in Pleistocene of Spanish Bight, San Diego, and Barlow's ranch, Ventura.

*Living.*—Santa Cruz to San Diego (Cooper): Half Moon Bay (Arnold).

*Pleistocene.*—San Pedro (Cooper; Arnold): San Diego; Ventura (Arnold).

*(?) Pliocene.*—San Fernando (Cooper).

### 18. Yoldia scissurata *Dall.*

PLATE XVII, FIG. 13.

*Yoldia scissurata* DALL, Trans. Wagner Inst. Sci., Vol. III, Part 4, 1898, p. 595.

*Yoldia arctica* BROD. & Sby., Zool. Jour., 1829 (not of GRAY, Parry's Voyage App., 1824, *fide* DALL, Trans. Wagner Inst. Sci., Vol. III, 1898, p. 595).

Shell rather small, oval, compressed, very thin, translucent, only slightly narrowed posteriorly; umbones minute, slightly anterior to middle, the anterior margin is evenly convex; a thin lamina runs along the anterior margin from the umbo to the end of the shell; a much narrower one also

occurs on the posterior margin; surface sculptured concentrically as in *Y. cooperi* except that this incised sculpture is not in harmony with the incremental lines; hinge and teeth similar to *Y. cooperi.*

*Dimensions.*—Long. 20.4 mm.; alt. 10 mm.; diam. 4 mm.; from umbo to anterior end 9 mm.; to posterior end 12 mm.

This delicate little shell resembles *Y. cooperi* in many respects, but is easily distinguishable by its smaller size, more delicate shell, the peculiar way in which the sculpture crosses the incremental lines, and by its relatively broader anterior end. Probably the *Y. amygdala* Val. reported by Cooper (7th Ann. Rept. Cal. St. Min., 1888, p. 270) as occurring at Deadman Island is *Y. scissurata* Dall. Specimens identified by Dr. Dall.

Three specimens from lower San Pedro series of Deadman Island; rare. Specimens of *Y. scissurata* in the State Museum collection of fossils at Berkeley are labeled *Y. amygdala.* The specimen figured is from the lower San Pedro series at Deadman Island, and is now in the collection of Delos Arnold.

*Living.*—Puget Sound (Carpenter).

*Pleistocene.*—San Pedro (Arnold.

## Superfamily ARCACEA.

## Family VII. ARCIDÆ.

### *Subfamily PECTUNCULINÆ.*

### Genus **Glycymeris** *Da Costa.*

Shell orbicular, nearly equilateral, smooth or radiately striated; umbones central, divided by a striated ligamental area; hinge with a semicircular row of transverse teeth; adductors subequal; pallial line simple; margins crenated inside.

Type, *Arca glycymeris* Linn.

#### 19. **Glycymeris barbarensis** *Conrad.*

PLATE XVIII, FIG. 9.

*Axinea barbarensis* CON., Pac. R. R. Rept., Vol. VI, 1857, p. 71, Pl. III, fig. 11; Vol. VII, 1857, p. 194, Pl. VI, fig. 3.

*Axinea intermedia* (not of BROD.; not of CARPENTER, Brit. Assn. Rept., 1863, p. 644), of COOPER, in part, 7th Ann. Rept. Cal. St. Min., 1888, p. 230 (not of KEEP, West Coast Shells, 1892, p. 169; not of WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 192; not of DALL, Trans. Wagner Inst. Sci., Vol. III, Part 4, 1898, p. 608.

Shell of medium size, convex, thick, subcircular, with angular aspect at umbones caused by the anterior dorsal margin being nearly straight; posterior end rounded; anterior end angular; surface area between umbones and interior as in *G. septentrionalis.*

*Dimensions.*—Long. 33.3 mm.; alt. 32 mm.; diam. 22 mm.

Distinguishable from *G. septentrionalis* by wider, more trigonal shell and angular

aspect of anterior extremity. This fossil form of Conrad's is separated from the living *G. intermedia* by Dr. Dall. Specimens identified by Dr. Dall.

Rare in upper San Pedro series of San Pedro, Los Cerritos, Deadman Island and Crawfish George's. Found also in the Pleistocene of Pacific Beach, San Diego. The specimen figured is from the upper San Pedro series at San Pedro, and is now in the collection of Delos Arnold.

*Pleistocene.*—Santa Barbara (Conrad): San Pedro (Arnold): San Diego (Arnold).

### 20. **Glycymeris septentrionalis** *Middendorf.*

PLATE XVIII, FIG. 10.

*Pectunculus septentrionalis* MIDD., CARPENTER, Brit. Assn. Rept., 1856, p. 219.

Shell of medium size, nearly circular, convex, thick; umbones central, not prominent; surface sculptured with rather faint ridges of growth and radiating grooves, which are more or less interrupted by the ridges; triangular ligamental area between umbones divaricately striated; hinge with a semicircular row of transverse teeth; muscle impressions subequal; interior of margin crenulated.

*Dimensions.*—Long. 30 mm.; alt. 32.2 mm.; diam. 22 mm.

Distinguishable from *G. barbarensis* by its evenly rounded outline. Differs from Carpenter's living *P. septentrionalis* var. *subobsoleta* by having larger, thicker shell, greater convexity, and more pronounced sculpture. Specimens identified by Dr. Dall.

Rare in upper San Pedro series of San Pedro, Los Cerritos, Crawfish George's, Deadman Island and Long Beach. The specimen figured is from the upper San Pedro series at San Pedro, and is now in the collection of Delos Arnold.

*Living.*—Ukamok Island, Alaska coast (Carpenter).

*Pleistocene.*—San Pedro (Arnold).

## *Subfamily ARCINÆ.*

### Genus **Arca** *(Linné) Lamarck.*

Shell oblong, subquadrangular, gaping anteriorly or inferiorly; hinge linear, straight, formed of a large number of small pectinated teeth; ligament external, inserted upon a lozenge-shaped area between the beaks, beaks high, rather wide apart; muscular impressions very distinct; pallial impression entire.

Type, *Arca noæ* Linné.

### 21. **Arca labiata** *Sowerby.*

PLATE XVIII, FIG. 4.

*Arca labiata* SBY., CARPENTER, Brit. Assn. Rept., 1856, pp. 310, 363.

Shell of medium size and thickness, arculate below, straight above, with small but prominent presocœlous beaks; anterior extremity evenly rounded; posterior extremity angular near base, a rather prominent convex angle running from beak to lower portion of the posterior extremity; right

valve with twenty-eight square topped, rather narrow, radial ridges, separated by slightly narrower interspaces; cardinal area triangular, broad, faintly sculptured with parallel lines transverse to hinge line; two nearly equal series of teeth, crowded in middle, becoming slightly oblique and further separated at the distal ends; margins serrate.

*Dimensions.*—Long. 28 mm.; alt. 26 mm.; distance between dorsal and ventral margins 20 mm.; umbo to anterior extremity 11 mm.; to posterior extremity 17 mm.

This is the only *Arca* so far reported from the Pleistocene of the Pacific Coast. It has been reported by Carpenter as being one of the few species common to both the West Indian and Pacific (Panama) faunas. This species and *Hipponyx antiquatus*, which Carpenter considers equal to *H. mitrula* of the West Indian fauna, are the only two species which occur in the Pleistocene of San Pedro and the living fauna of the West Indies. These two species offer no proof of a close water connection between these two regions during Pleistocene time, for the occurrence in both regions of these two species is merely accidental, or a coincidence. The specimen described was identified by Dr. Dall.

Rare in the upper San Pedro series of San Pedro; two specimens, a right and a left valve. The specimen figured is from the upper San Pedro series at San Pedro, and is now in the collection of Delos Arnold.

*Living.*—Gulf of California; Central America; West Indies (Carpenter).

*Pleistocene.*—San Pedro (Arnold).

## Superfamily OSTRACEA.

## Family VIII. OSTREIDÆ.

### Genus **Ostrea** *(Linné) Lamarck.*

Shell irregular, attached by the left valve; upper valve flat or concave, often plain; lower convex, often plaited or foliaceous, and with a prominent beak; ligamental cavity triangular or elongated; hinge toothless, structure subnacreous, laminated, with a prismatic-cellular substance between the margins of the laminæ.

Type, *Ostrea edulis* Linné.

#### 22. **Ostrea lurida** *Carpenter.*

*Ostrea lurida* CPR., Brit. Assn. Rept., 1863, p. 645; Jour. de Conch., Vol. XII, 1865, p. 137. GABB, Pal. Cal., Vol. II, 1869, p. 106. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 256. KEEP, West Coast Shells, p. 164, 1892. WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 193. DALL, Trans. Wagner Inst. Sci., Vol. III, Part 4, 1898, p. 687.

Shell of medium size, irregular, suborbicular, ellipsoidal, or elongated; surface laminated and sometimes irregularly plaited; beak prominent; hinge toothless.

*Dimensions.*—Long. 35 mm.; alt. 50 mm.

Grades into two varieties, *expansa* Cpr., which is nearly circular, and *rufoides* Cpr., which is of a reddish hue on the interior. Specimen identified by Dr. Dall.

Typical form exceedingly common in the upper San Pedro series of San Pedro, Los Cerritos and Long Beach; rare in the lower San Pedro series of Deadman Island and San Pedro. Found also in Pleistocene of Twenty-sixth street and Pacific Beach, San Diego.

*Living.*—Straits of Fuca to San Diego (Cooper).

*Pleistocene.*—Benicia, Solano County; San Diego (Cooper; Arnold): San Pedro (Arnold).

## Superfamily PECTINACEA.

### Family IX. PECTINIDÆ.

#### Genus **Pecten** *Müller.*

Shell suborbicular, regular, resting on the right valve, usually ornamented with radiating ribs; beaks approximate, eared; anterior ears most prominent; posterior side a little oblique; right valve most convex, with a notch below the front ear; hinge margins straight, united by a narrow ligament; cartilage internal, in a central pit; adductor impression double, obscure; pedal impression only in the left valve, or obsolete.

Type, *Ostrea maxima* Linné.

#### Subgenus **Pecten** *s. s.*

Right valve moderately inflated, left valve flattish; sculpture of strong ribs with radial striation, more or less roughened by simple concentric lamellation or incremental sculpture; ears subequal.

Type, *Pecten maximus* Linné.

##### [S. B.] **Pecten (Pecten) bellus** *Conrad.*

PLATE XXI, FIGS. 1 AND 2.

*Janira bella* CONRAD, Proc. Acad. Nat. Sci. Phila., 1856, p. 312; Pac. R. R. Rept., Vol. VI, 1857, p. 71, Pl. III, fig. 16. GABB, Pal. Cal., Vol. II, 1869, Pl. XVI, fig. 20. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 244; not *P. bellis* McCOY (*teste* DALL).

*Pecten (Pecten) hemphilli* DALL, Trans. Wagner Inst. Sci., Vol. III, Part 4, 1898, p. 706 (*pars. ?*).

*Pecten (Pecten) bellus* CON., DALL, Trans. Wagner Inst. Sci., Vol. III, Part 4, 1898, p. 704.

Shell large, thin, inequivalve, elegantly, radiately ribbed. Left (upper) valve slightly convex, the point of greatest convexity being generally about one-fourth the distance from the apex toward the ventral margin; between this point of greatest convexity and the apex there is a deeply depressed area, the depression generally not affecting the two outer ribs on each side, which inclose the depression on the sides; surface of left valve ornamented by thirteen or fourteen prominent, flat-topped, sometimes faintly bicarinated, radiating ribs, which have flat, sloping sides; these ribs become broader, less elevated and less sharply angulated near the periphery in the adult; interspaces slightly wider than the tops of the ribs, with slightly rounded bottoms; whole surface of left disk covered with fine, sharp, concentric, regular lamellæ; ears rather small, subequal, slightly concave, finely concentrically lamellated, separated from the disk by an impressed line. Right (lower) valve prominently convex, the point of greatest convexity being about one-third the distance from the apex to the ventral margin of the disk; the umbo in this valve curves sharply and meets the plane of the ears at an angle of

about ninety degrees; surface of right valve ornamented by fourteen or fifteen prominent, nearly flat-topped, square, radiating ribs, some of them with one or two longitudinal obsolete lines; the ribs become somewhat less elevated and the sides more sloping as the periphery is approached in the adult; surface of right disk ornamented with close, fine, squamose, concentric wrinkles; ears subequal, arched, covered with crowded, elevated lamellæ; byssal notch small.

*Dimensions.*—Alt. 80 mm.; lat. 108 mm.; diam. 32 mm.; length of hinge-line, 45 mm.

Found in the Pliocene at Santa Barbara, California (Conrad, Gabb, Yates Cooper, Arnold).

The description, measurements, and figures are of Gabb's type specimen of *Janira bella* (No. 960, Collection Academy Natural Sciences, Philadelphia), which was kindly loaned to the writer by Professor H. A. Pilsbry, Curator of Mollusca.

*P. stearnsii* and *P. diegensis* are distinguishable from *P. bellus* by the more numerous (25 or 28 in the first, 20 or 22 in the second), narrower, sharper defined, perpendicular-sided, radiating ribs on the right valve, and by evenly rounded, prominently and evenly lamellated ribs of the left valve. *P. hemphilli* is distinguishable from *P. bellus* by its smaller size; by having on the right valve more numerous (15 or 16 in the former), round-topped, narrower, nearly perpendicular-sided, radiating ribs, which retain their prominence for their entire length, and by the less convexity of the disk, more numerous, narrower and more elevated radiating ribs of the left valve. *P. hemphilli* has the same depression below the apex in the left valve, but the less degree of convexity of the rest of the disk lessens the prominence of the depression, which is so marked in most specimens of *P. bellus*. *P. dentatus* is distinguishable from *P. bellus* by its smaller size, greater convexity of right valve, greater concavity of left valve, greater number of ribs, and by the auxiliary ribs in the left valve.

After a careful comparison of a large series of *P. bellus* with Conrad's description and figure and Gabb's figure and type specimen, the writer has no hesitancy in adopting the synonymy given at the beginning of this article. Dall is of the opinion that Conrad's species and that of Gabb are different. This idea was probably caused by the exaggeration of the bicarination of the ribs in Conrad's figure. Several of the specimens of *P. bellus* examined by the writer show this bicarination to a greater or less degree, although as a rule the ribs are nearly smooth-topped. A large series of *P. bellus* and *P. hemphilli* show the differences enumerated in a previous paragraph to be constant for the adults. The young of both species up to an altitude of twenty millimeters are nearly identical in appearance.

### 23. Pecten (Pecten) dentatus *Sowerby*.

PLATE XII, FIGS. 1 AND 1*a*.

*Pecten dentatus* SBY., Thes. Conch., Vol. I, p. 39, Pl. XV, figs. 105, 106. DALL, Trans. Wagner Ins. Sci., Vol. III, Part 4, 1892, p. 707.

*Vola dentata* SBY., H. &. A. ADAMS, Gen. Rec. Moll.

*Janira dentata* SBY. (=*J. excavata*, VAL., *fide* CARPENTER, Brit. Assn. Rept., 1863, p. 654). GABB, Pal. Cal., Vol. II, 1869, p. 104. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 244 (=*P. stearnsii* DALL, in part).

Shell of medium size, subcircular, inequivalve, concavo-convex, rather thin; right valve gibbous, with twenty smooth, rounded, only moderately convex ribs, separated by very faintly channeled, narrow interspaces; surface smooth except for fine, undulating lines of growth; ears on this valve convexly bent, and separated from the disk by a deep groove; anterior ear with small byssal notch, obsoletely, radiately ribbed, and with fine incremental lines; posterior ear similar except that it lacks the notch; left valve concave, with nineteen or twenty prominent squarish ribs, which are separated by deep channeled interspaces of equal width with the ribs; a faint rounded rib runs along the middle of each of the interspaces; surface with fine undulating incremental lines; ears of this valve concave, with obsolete radiating ridges and fine lines of growth.

*Dimensions.*—Long. 70 mm.; alt. 67 mm.; diam. 25 mm.; hinge 35 mm.

Distinguishable from *P. hemphilli* Dall by greater convexity of the right valve, and by the greater number of ribs, *P. hemphilli* having only about fifteen ribs; distinguishable from *P. stearnsii* and *P. diegensis* Dall by greater convexity of right valve, low rounded ribs rather than square ones on this valve; and by square ribs, between which are faint rounded riblets, rather than sharply rounded ribs on the left valve. *P. dentatus* is of the same shape as the Japanese species *P. laqueatus* Sby., which has fewer, but squarer, broader ribs on the right valve. This last species has been reported from the Tertiary of Japan by Dr. Brauns in his Geology of the Environs of Tokio.[1] "*P. laqueatus* has been erroneously cited by Reeve from California" (Dall).

An almost perfect right valve of this beautiful southern shell was found in the upper San Pedro series of San Pedro. It differs from a living specimen from the Gulf of California by having twenty rather than twenty-three ribs, and by having slightly less convex ribs and wider interspaces. In degree of convexity and in its ears it agrees exactly with the living shell. The specimen was identified by Dr. Dall.

Cooper has mistaken the flat valve of *P. stearnsii* for this species. A specimen in the State Museum collection at the University of California, Berkeley, labeled "*Janira dentata* Sby., San Pedro, Quaternary," is a *P. stearnsii* from the Pliocene of Deadman Island.

The specimen figured is a living shell from the Gulf of California, and is now in the collection of the Department of Geology, Leland Stanford Junior University.

*Living.*—Gulf of California (Carpenter; Button).

*Pleistocene.*—Santa Barbara to San Diego (Cooper): San Pedro (Arnold).

*Pliocene.*—San Diego well (Cooper)—(probably *P. hemphilli*).

### [S. D.] Pecten (Pecten) hemphilli *Dall.*

*Pecten hemphilli* DALL., Proc. U. S. Nat. Mus., Vol. I, 1879, p. 15. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 257. DALL, Trans. Wagner Inst. Sci., Vol. III, Part 4, 1898, p. 706. Not *Janira bella* CON., Pac. R. R. Rept., Vol. VI, 1857, p. 71, Pl. III, fig. 16; nor GABB, Pal. Cal., Vol. II, 1869, Pl. XVI, fig. 20.

Shell of medium size, thin, inequivalve. Upper (left) valve flat or slightly concave, with a concave depression between middle of valve and umbo; surface of this valve sculptured by sixteen

[1] Mem. Univ. Tokio, No. 4, 1881, p. 48, Pl. VII, fig. 31.

or seventeen very prominent, rather narrow radiating ribs, which are nearly flat-topped and have nearly perpendicular sides; interspaces wider than ribs, with rounding bottoms; fine incremental lamellæ cover the surface of this valve; ears square-cornered and concave, covered with incremental lamellæ. Lower (right) valve convex, most apparent between middle of valve and umbo; sculptured by sixteen prominent squarish ribs, which are similar to those on the upper valve, except that they are slightly broader and have a more rounded top; whole surface sculptured by very fine incremental lines; ears similar to those of upper valve except convex, and the right one having three or four radiating ridges and a small byssal notch.

*Dimensions.*—Long. 63 mm.; alt. 56 mm.; diam. 15 mm.; hinge-line 28 mm.

This species is readily distinguishable from *P. stearnsii* and *P. diegensis* by its smaller size, greater convexity of lower valve, and fewer ribs. Distinguishable from *P. bellus* by smaller size, flat or concave upper valve, and narrow, more elevated and prominent radiating ribs. Common in the upper horizon of the Pliocene at Pacific Beach, and also in the strata exposed on Tenth Street, near Russ School, San Diego.

*Pliocene.*—Pacific Beach and Russ School, San Diego (Hemphill; Dall; Arnold).

### 24. Pecten (Pecten) stearnsii *Dall.*

PLATE XII, FIG. 3.

*Pecten stearnsii* DALL., Proc. U. S. Nat. Mus., Vol. I, 1878, p. 14; Trans. Wagner Inst. Sci., Vol. III, Part 4, 1898, p. 706, Pl. XXVI, fig. 5.

*Janira dentata* SBY. (?), GABB, Pal. Cal., Vol. II, 1869, p. 104 (in part). COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 244 (in part).

Shell of medium size, subcircular, inequivalve, concavo-convex, thin; right valve slightly convex, with about twenty-six regular, even, square ribs, separated by channeled interspaces somewhat narrower than the ribs; the top surface of each rib is flattened with a broad, shallow groove in the middle, with one or two faint riblets on each side of the groove; whole surface covered with concentric lamellæ which are much finer and about twice as crowded as those of the left valve; left valve flattened or concave, with about twenty-four regularly rounded, vaulted, even ribs, separated by slightly wider channeled interspaces; the whole surface covered with fine, sharp, concentric, regular lamellæ, a little looped backward over the tops of the ridge; ears of this valve concave, with obsolete radiating ridges, and fine, concentric lamellæ; ears of right valve subequal, arched, covered with crowded, elevated lamellæ; byssal notch very small.

*Dimensions.*—Long. 71 mm.; alt. 62 mm.; diam. 14 mm.; hinge 25 mm.

"This is the Pliocene precursor of *P. diegensis* Dall (Plate XII, fig. 5), (*P. floridus* of Hinds, not of Gmelin) from which it differs by having five or six more ribs, which, in the adult, have a conspicuous median sulcus." (Dall.) Mrs. Oldroyd has eight *P. diegensis* which have been hauled up in the fishermen's nets at San Pedro; two of these are over six inches in diameter and are exceptionally high colored for this species.

Two imperfect left valves from the Pliocene of Deadman Island. The figure is of a left valve from the Pliocene of San Diego. Specimens identified by Dr. Dall.

*Pliocene.*—San Pedro (Arnold): San Diego (Pacific Beach, lower horizon), (Dall; Hamlin; Hemphill; Arnold).

### Subgenus **Chlamys** *Bolten.*

Valves moderately inflated, subequal, in general similar (except in color); sculpture of radial ribbing with or without *Camptonectes* striation, with or without an imbricate surface layer; frequently spinose on the ridges; ears often discrepant, the posterior smaller.

Type, *Pecten islandicus* (Müller).

### Section *Patinopecten Dall.*

Valves with small ribs, flat on the right valve and sometimes dichotomous; smaller and more rounded on the left valve; concentric sculpture inconspicuous; radial striæ absent or obsolete; ears subequal; valves nearly equilateral.

Type, *Pecten caurinus* (Gld.).

### 25. Pecten (Patinopecten) caurinus *Gould.*

PLATE XIII, FIG. 6.

*Pecten caurinus* GLD., Proc. Bost. Soc. Nat. Hist., Vol. III, 1850, p. 345; Wilkes Expl. Exped., Vol. XII, 1852, p. 458, fig. 569. WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 193; = *P. yessoënsis* CPR., (non JAY, 1856); = *P. propatulus* CARPENTER (non CONRAD, 1849) (*fide* DALL., Trans. Wagner Inst. Sci., Vol. III, Part 4, 1898, p. 710).
*Amusium caurinum* GLD., CARPENTER, Brit. Assn. Rept., 1863, p. 645. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 228. KEEP, West Coast Shells, p. 168, 1892.

Shell large, nearly circular, flat inequivalve, rather thin; right valve with twenty strong, flat-topped, smooth, squarish ribs, with interspaces wider than the ribs; left valve less convex than right, with seventeen rather acutely rounded ribs, with wide, shallow interspaces; surface of left valve sculptured by regular, fine, undulating, concentric lines; ears not large, obliquely truncated at ends.

*Dimensions.*—Long. 110 mm.; alt. 110 mm.; diam. 16 mm.; hinge 46 mm.

This large, flat *Pecten* is distinguishable from the others of this genus found in these deposits by its size and shape. *P. expansus* Dall differs from this species by having twenty-five to thirty dichotomous ribs. *P. yessoënsis* from Amori, Rikonoken, Japan, differs from *P. caurinus* by having a more convex shell, wider, lower, more rounded ribs on the right valve, less prominent ribs on the left valve, and by having larger ears, which are truncated more nearly at right angles at the ends. *Pecten propatulus* Conrad is more convex and has fewer but stronger ribs and narrower interspaces on the right valve. Specimens identified by Dr. Dall.

Common in the Pliocene of Deadman Island and Timm's Point; rarer in the lower San Pedro series of Deadman Island and San Pedro. Also found in Pleistocene on beach near bath-house and in Pliocene at Packard's Hill, Santa Barbara. The specimen figured is from the Pliocene of Deadman Island and is now in the collection of Delos Arnold.

*Living.*—Puget Sound (Carpenter).

*Pleistocene.*—Santa Barbara; San Pedro (Cooper; Arnold).

*Pliocene.*—Eagle Prairie, Humboldt County; San Fernando (Cooper).

[S. D.] **Pecten (Patinopecten) expansus** *Dall.*

*Pecten expansus* DALL, Proc. U. S. Nat. Mus., Vol. I, 1879, p. 14; Trans. Wagner Inst. Sci., Vol. III, Part 4, 1898, p. 706.

Shell large, thin, slightly convex; outer surface of upper (left) valve marked by sixteen to twenty sharp radiating ridges, but slightly elevated, and whose sides shade off insensibly into the broad interspaces; faint indications of ridges appear between the principal ones; surface of upper valve covered with fine, slightly raised, sharp lamellæ; lower (right) valve with twenty or thirty dichotomous ribs, flattened above, but not sharply differentiated from the interspaces, sculptured with fine lines of growth, with faint appearances of radiating striæ; ears rather small, and distinctly but not strongly marked off from the disk; byssal notch rounded, moderately deep.

*Dimensions.*—Long. 140 mm.; alt. 135 mm.; diam. 32 mm.; hinge-line 65 mm.

This species is close to *P. caurinus*, but may be distinguished by the dichotomous ribs on the lower valve, and the faint ribs between the principal ones on the upper. A species of *Pecten* near, if not identical, to *P. expansus* is found in the Pliocene near Purisima, San Mateo County, California. *P. expansus* is common in the lower horizon of the Pliocene at Pacific Beach, near San Diego.

*Pliocene.*—Pacific Beach, San Diego (Hemphill; Dall; Hamlin; Arnold).

Section *Nodipecten Dall.*

Both valves convex, usually of large size and heavy; ribs intermittently nodose, with more or less prominent hollow nodes or buttæ; radial striation pronounced; ears unequal, the posterior smaller; the valves often more or less oblique; imbricate surface layer sometimes very marked.

Type, *Pecten nodosus* Linné.

**26. Pecten (Nodipecten) subnodosus** *Sowerby.*

*Pecten subnodosus* SBY., Proc. Zool. Soc., 1835, p. 109. CARPENTER, Brit. Assn. Rept., 1856, p. 311; Brit. Assn. Rept., 1863, p. 621. DALL, Trans. Wagner Inst. Sci., Vol. III, Part 4, 1898, p. 710.
*Pecten intermedius* CON., Am. Jour. Conch., Vol. III, 1867, p. 7.

Shell large, suboval, convex; surface sculptured with numerous high, square ribs, three or four of which are generally more prominent than the others; interspaces deeply channeled, averaging about equal in width with the ribs; surface, including the ribs and interspaces, sculptured by fine radiating, squamose ridges, and fine lines of growth; ears rather small, sculptured in same manner as the disk.

*Dimensions.*—Long. 120 mm.; alt. 125 mm.; diam. 45 mm.

This large tropical species is distinguishable by strong elevated ribs and peculiar squamose, radiating ridges. Dr. Dall says of this species: "There seems to be little reason for separating this form from the *P. nodosus* of the Antilles. Both vary through a strictly analogous series of mutations."

One-half of a large left valve was found in the upper San Pedro conglomerate of Deadman Island by Dr. A. A. Wright, who also found a young specimen of the same species in the upper San Pedro series of San Pedro.

*Living.*—Lower California to Panama (Carpenter).

*Pleistocene.*—San Pedro; San Diego (Arnold): Cerros Island and Lower California (Dall).

Section *Chlamys s. s.*

Ribs small and numerous, imbricate or spinose; valves subequal, similar, oblique, or with unequal ears, the posterior smaller; *Camptonectes* striation and imbricate surface layer usually present; shell usually solid and opaque; byssal notch and ctenolium present.

Type, *Pecten islandicus* (Müller).

### 27. Pecten (Chlamys) hastatus *Sowerby.*

PLATE XI, FIGS. 4 AND 4*a*.

*Pecten hastatus* SBY., Thes. Conch., 1843, p. 72, Pl. XXII, fig. 236 (not of CARPENTER, Brit. Assn. Rept., 1863, p. 645 = *P. hericeus* GLD.); (? not of GABB, Pal. Cal., Vol. II, 1869, p. 104); (? not of COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 257). DALL, Trans. Wagner Inst. Sci., Vol. III, Part 4, 1898, p. 708.

Shell similar in shape and general characteristics to *P. hericeus.* Left valve sculptured with eight to ten prominent, narrow, convex, coarsely spinose, radiating ribs separated by interspaces several times wider than the ribs; interspaces ornamented with fasciculi of small spinose ribs, which in some cases have only the importance of spinose lines; anterior ear large, acutely pointed, with three or four prominent, spinose, radiating ribs; right valve with eight to ten pairs of equally prominent, coarsely spinose ribs, each pair separated from the next by deep rounded interspaces along the bottoms of which run fine spinose lines; the members of each pair of ribs separated from each other by interspaces about as wide as one rib, and also ornamented with spinose lines; anterior ear with four or five strong spinose ribs and separated from disk by deep notch; posterior ears nearly obsolete, radiately spinose.

*Dimensions.*—Long. 54 mm.; alt. 61 mm.; diam. 21 mm.; hinge 28 mm.

Distinguishable from *P. hericeus* by the less numerous, but more prominent and more strongly spinose radiating ribs. Dr. Dall[1] says that Carpenter confused *P. hericeus* with *P. hastatus*, and as Gabb and Cooper have probably used Carpenter's *P. "hastatus"* as their type, their localities for that species would come under *P. hericeus.*

Mrs. Oldroyd has a beautiful pair of *Pecten hastatus* which was taken from a fisherman's net at San Pedro. Dr. Dall identified this shell and said that it was the first genuine *P. hastatus* that had ever been found at San Pedro. This species is a northern form.

Rare in Pliocene and lower San Pedro series of Deadman Island; one specimen from upper San Pedro series of Crawfish George's. The specimen figured is from the Pliocene of Deadman Island, and is now in the collection of Delos Arnold. Found also in the Pliocene at Packard's Hill, Santa Barbara, and Pacific Beach, San Diego; and in the Pleistocene at the bath-house, Santa Barbara.

*Living.*—San Pedro (Oldroyd; Raymond).

*Pleistocene.*—San Pedro; Santa Barbara (Arnold).

*Pliocene.*—San Pedro; Santa Barbara; San Diego (Arnold).

[1] Trans. Wagner Inst. Sci., Vol. III, 1898, p. 708.

### 28. Pecten (Chlamys) hericeus *Gould.*

PLATE XI, FIG. 2.

*Pecten hericeus* GLD., Proc. Bost. Soc. Nat. Hist., Vol. III, 1850, p. 345; Wilkes Expl. Exped., Vol. XII, 1852, p. 457, fig. 570. DALL, Trans. Wagner Inst. Sci., Vol. III, Part 4, 1898, p. 708.

*Pecten hastatus* of CARPENTER, Brit. Assn. Rept., 1863, p. 645 (not of SOWERBY, Thes. Conch., 1843). ? GABB, Pal. Cal., Vol. II, 1869, p. 104. ? COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 257.

Shell of medium size, triangular ovate, compressed, equivalve, thin; surface of left valve sculptured by about fourteen to sixteen groups of fasciculated ribs, the groups being more prominent and containing more ribs as the middle of the shell is approached; the surface of all the ribs roughened by numerous rather small, erect, arched spines; right valve nearly the same as left; anterior ear of left valve large, acutely pointed with seven to eight sharp, squamosely striated radiating ribs; posterior ear nearly obsolete; ears of right valve the same except that a deep byssal notch separates anterior ear from disk; sides of umbo rise abruptly from ears.

*Dimensions.*—Long. 40 mm.; alt. 47 mm.; diam. 12 mm.; hinge 19 mm.

This species resembles *P. hastatus* in shape and general characteristics. In *P. hastatus* there are seven to ten strong, narrow, prominent ribs, coarsely spinose, while in *P. hericeus* the ribs occur in fourteen to sixteen fasciculi, each fascicle consisting of three or four nearly equally prominent, finely spinose ribs, and forming a convex ridge. Specimens identified by Dr. Dall.

Rare in Pliocene of Deadman Island. The specimen figured is from that horizon and is now in the collection of Delos Arnold. Found rarely in the Pliocene of Pacific Beach, San Diego.

*Living.*—Straits of Fuca (Gould): ? Sitka to Santa Barbara (Cooper).

*Pleistocene.*—San Diego (Dall): ? Santa Barbara to San Diego (Cooper): San Pedro (Arnold).

*Pliocene.*—San Pedro (Arnold): ? Santa Barbara; San Fernando; San Diego well (Cooper): San Diego (Arnold).

### 29. Pecten (Chlamys) hericeus var. strategus *Dall.*

PLATE XI, FIG. 5.

*Pecten hericeus* var. *strategus* DALL, Trans. Wagner Inst. Sci., Vol. III, Part 4, 1898, p. 709.

Shape and general texture same as *P. hericeus.* "The fasciculi of the left valve, to the number of five to seven, with the riblets coalescent, forming large, smooth-backed, turgid ribs, with smaller imbricate intercalary threads. The large ribs sometimes break up suddenly into the usual small riblets near the base. The recent specimens are bright scarlet." (Dall). The right valve of a young from the Pleistocene of Deadman Island shows nine fasciculi, most of which seem to be made up of two riblets which keep their individuality to the umbo, instead of coalescing; the interspaces are slightly narrower than the fasciculi. The anterior ear of this right valve is prominent and ornamented with six radiating ribs, and near the disk, by elevated lines of growth; byssal notch rather deep; whole surface ornamented with minute, lattice-like sculpture.

*Dimensions.*—Long. 18 mm.; alt. 21 mm.; diam. 5.2 mm.; hinge 9.4 mm.

Distinguishable by the few prominent, sulcated ridges, and smooth surface, except for minute sculpture. Specimens identified by Dr. Dall.

Two specimens from the lower San Pedro series of Deadman Island, one of which is figured, and is now in the collection of Delos Arnold.

*Living.*—Unalaska (Dall).

*Pleistocene.*—Alaska (Dall): San Pedro (Arnold).

### 30. Pecten (Chlamys) jordani, sp. nov.

PLATE XII, FIGS. 6 AND 7.

Shell of medium size, shape of *P. hericeus*, inequivalve, rather thin; right valve with twenty-five to thirty angular, smooth-topped, imbricated ribs, which become dichotomous after reaching a length of about 30 mm.; interspaces deeply channeled and narrower than ribs; anterior ear imperfectly radially ribbed with six ridges, and showing elevated, concentric, incremental lines; posterior ear nearly obsolete, showing four ribs; byssal notch not deep; left valve shows twenty-five to thirty narrow, convex ribs, showing imbrications only slightly; interspaces as large as ribs; after a diameter of about 30 mm. has been reached by the shell, small riblets appear in the widening interspaces; anterior ear shows five narrow, imbricated ridges, with wide interspaces; both valves show a tendency to contract suddenly at the basal margin upon nearing completion of growth; surface of both valves covered with a minute, lattice-like sculpture, which is generally worn off on exposed portions of the shell.

*Dimensions.*—Long. 42 mm.; alt. 45 mm.; diam. 15 mm.; hinge 18 mm.

Allied to *P. opuntia* Dall, but having fewer ribs on disk and ear, and having dichotomous ribs after reaching a diameter of 35 mm. Distinguished from *P. hericeus* and *P. hastatus* by not having fasciculated nor spinose ribs.

Rare in Pliocene of Deadman Island and lower San Pedro series of Deadman Island. Found also in Pliocene of Packard's Hill and Pleistocene of bath-house, Santa Barbara.

The specimen figured is the type, which is from the Pliocene of Deadman Island and is now in the United States National Museum.

*Pleistocene.*—San Pedro, Santa Barbara (Arnold).

*Pliocene.*—San Pedro, Santa Barbara (Arnold).

### 31. Pecten (Chlamys) latiauritus *Conrad.*

PLATE XII, FIGS. 2 AND 2*a*.

*Pecten latiauritus* CON., Jour. Phil. Acad. Sci., Vol. VII, 1837, p. 238, Pl. XVIII, fig. 9. REEVE, Conch. Icon., Pl. I, sp. 5. SOWERBY, Thes. Conch., Pl. I, p. 57. CARPENTER, Brit. Assn. Rept., 1863, p. 645. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 257. KEEP, West Coast Shells, p. 167, 1892. WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 193; = *P. tunica* PHIL., 1844, + *P. mesotimeris* SOWERBY, 1847 (*fide* DALL, Trans. Wagner Inst. Sci., Vol. III, Part 4, 1898, p. 709.)

Shell small, suboval, inequivalve, subequilateral, compressed, thin; surface ornamented with from twelve to fifteen squarish, elevated, distinct ribs, with about equal, channeled interspaces; ribs often mesially grooved; hinge line wide, the ears pointed above.

*Dimensions.*—Long. 25 mm.; alt. 23 mm.; diam. 9 mm.; hinge 20 mm.

This is the type form and is distinguishable by acutely pointed ears, distinct, squarish ribs and wide shell. Specimens identified by Dr. Dall.

Common in upper San Pedro series of San Pedro, Los Cerritos, Crawfish George's, Deadman Island, San Pedro, and Long Beach; rare in lower San Pedro series of Deadman Island and San Pedro. Found also at Spanish Bight and Twenty-sixth Street, San Diego. The specimen figured is from the upper San Pedro series at San Pedro, and is now in the collection of Delos Arnold.

*Living.*—Santa Barbara to San Diego (Carpenter).

*Pleistocene.*—Santa Barbara; San Pedro (Cooper): San Pedro (Arnold): San Pedro; San Diego (Dall): San Diego (Arnold).

### 32. Pecten (Chlamys) latiauritus *Con.*, var. fragilis, var. nov.

PLATE XII, FIG. 8.

Shell of same general type as *P. latiauritus*. More compressed and much thinner; ribs seven to nine, very low and rounded, with shallow, rounded interspaces; surface smooth, the concentric sculpture being nearly obsolete; hinge long, ears sharply pointed.

*Dimensions.*—Long. 26 mm.; alt. 26 mm.; diam. 78 mm.; hinge 25 mm.

Distinguishable from var. *flucicolus* Dall, which it resembles, by having a longer hinge-line and pointed ears.

Rare in upper San Pedro series of San Pedro and Los Cerritos. The specimen figured is the type, which is from the upper San Pedro series at San Pedro, and is now in the United States National Museum.

*Pleistocene.*—San Pedro (Arnold).

### 33. Pecten (Chlamys) latiauritus *Con.*, var. monotimeris *Con.*

PLATE XII, FIGS. 4 AND 4*a*.

*Pecten monotimeris* CON., Jour. Phil. Acad. Sci., Vol. VII, 1837, p. 233, Pl. XVIII, fig. 10. CARPENTER, Brit. Assn. Rept., 1863, p. 645. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 257. KEEP, West Coast Shells, p. 167, fig. 140, 1892.

*Pecten latiauritus* var. *monotimeris* CON., DALL, Trans. Wagner Inst. Sci., Vol. III, Part 4, 1898, p. 709.

Shell resembling *P. latiauritus*, but more oblique, inflated, and markedly shorter, with smaller ears.

*Dimensions.*—Long. 19 mm.; alt. 20 mm.; diam. 9 mm.

Rare in lower San Pedro series of Deadman Island and San Pedro, and in upper San Pedro series of Los Cerritos, San Pedro, Long Beach, and Crawfish George's. Found also in Pleistocene of Spanish Bight, San Diego, and Barlow's ranch, Ventura. The specimen figured is from the upper San Pedro series at San Pedro, and is now in the collection of Delos Arnold.

*Living.*—Santa Barbara to San Diego (Dall).

*Pleistocene.*—Santa Barbara; San Pedro (Dall): San Pedro; San Diego; Ventura (Arnold).

[S. D.] **Pecten (Chlamys) opuntia** *Dall.*

*Pecten (Chlamys) opuntia* DALL, Trans. Wagner Inst. Sci., Vol. III, Part 4, 1898, p. 707, Pl. XXIX, fig. 6.

Shell of medium size, allied to *P. hericeus* var. *navarchus* Dall, from which it differs by its smaller and not fasciculated radial ribs, more elongated anterior ear, more densely, radially costate posterior ear, small size when adult, and by a tendency to be suddenly contracted at the basal margin on the completion of growth.

*Dimensions.*—Long. 32.5 mm.; alt. 35 mm.

This species is distinguishable from the allied species by the large number (forty or fifty) of unfasciculated imbricated ribs, which are of about equal prominence.

Found in the Pliocene at Pacific Beach, near San Diego, and in the Pliocene at Packard's Hill, Santa Barbara.

*Pliocene.*—Santa Barbara (Arnold): San Diego (Hemphill; Hamlin; Arnold).

Section *Plagioctenium Dall.*

Shell thin, orbicular, with subequal inflated valves, usually equilateral, with uniform, well-marked radial, not dichotomous ribs; the concentric sculpture in looped lamellæ; the ribs strong, frequently smooth above; the submargins impressed below the subequal auricles; the valves well inflated, with a tendency to oblique growth in the adult.

Type, *Pecten ventricosus* Sowerby.

**34. Pecten (Plagioctenium) newsomi,** sp. nov.

PLATE XI, FIGS. 1 AND 1*a*.

Shell of medium size, ovate-triangular, compressed, equilateral, rather thin; twenty-two stout, smooth-topped, squarish ribs, with channeled interspaces of same width as ribs; interspaces and sides of ribs showing sharp imbricating lines of growth; ears of left valve subequal, with subacute corners; surface of ears radially striated, and showing sharp incremental lines.

*Dimensions.*—Long. 24 mm.; alt. 26 mm.; diam. 8 mm.; hinge 16 mm.; angle of dorsal margins 87 degrees.

This variety is distinguishable from *P. ventricosus* by the much smaller angle (87 degrees) made by the dorsal margins of the disk, that of a typical *P. ventricosus* being about 110 degrees. *P. newsomi* is also very much less ventricose than the latter, and has much narrower ridges, wider interspaces, and a thinner shell; distinguishable from *P. subventricosus* by much smaller angle formed by dorsal margins, and by narrower ridges. It resembles *P. subventricosus* in degree of convexity. This species is named in honor of Dr. John F. Newsom, of Leland Stanford Junior University.

Rare in upper San Pedro series of San Pedro and Los Cerritos. The specimen figured is the type, which is from the upper San Pedro series at Los Cerritos, and is now in the United States National Museum.

*Pleistocene.*—San Pedro (Arnold).

[S. D.] **Pecten (Plagioctenium) subventricosus** *Dall.*

*Pecten (Plagioctenium) subventricosus* DALL, Trans. Wagner Inst. Sci., Vol. III, Part 4, 1898, p. 707, Pl. XXIX, fig. 8.

"Shell of the type of *P. ventricosus* Sby., from which it differs by being smaller and less tumid, less expanded laterally, with the ribs rounded, instead of flattened, above, and with narrow interspaces; the tops of the ribs smooth, the sides with a dense fringe of concentric lamellæ." (Dall).

*Dimensions.*—Long. 65 mm.; alt. 65 mm.; diam. 24 mm.

Several specimens of this species were found in the Pliocene of Pacific Beach, near San Diego.

*Pliocene.*—Ventura County (Bowers): San Diego (Hemphill; Stearns; Arnold).

### 35. Pecten (Plagioctenium) ventricosus *Sowerby.*

PLATE XI, FIGS. 3, 3*a*, 6 AND 6*a*.

*Pecten ventricosus* SBY., Thes. Conch., *Pecten*, 1843, p. 51, Pl. XII, figs. 18, 19. GABB, Pal. Cal., Vol. II, 1869, p. 104. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 258. = *P. tumidus* SBY., 1835 (not of TURT., 1822, nor of ZEITEN, 1830) = *P. circularis* SBY. (*ex parte*) = *P. inca* D'ORB., 1847 (*fide* DALL., Trans. Wagner Inst. Sci., Vol. III, Part 4, 1898, p. 710).

Shell thin, orbicular, with subequal inflated valves which are subequilateral; uniformly radiately ribbed; about twenty-two strong, angular, even ribs separated by narrow interspaces; the whole surface covered with fine, sharp, concentric, looped lamellæ, which exhibits the oblique growth in adult shells; ears moderately small, nearly equilateral in left valve; byssal notch prominent; surface of ears ornamented with fine concentric lamellæ of growth, and sometimes with radiating ridges.

*Dimensions.*—Long. 59 mm.; alt. 50 mm.; diam. 32 mm.; hinge 31 mm.; angle of dorsal margin 110 degrees.

*P. æquisulcatus* Carpenter resembles this species very closely, but is thinner and flatter and has narrower ribs. Probably all the Pleistocene forms would come under the head of *P. ventricosus*, but many of them have been labeled *P. æquisulcatus*. Specimens identified by Dr. Dall.

Figures 6 and 6*a*, Plate XI, represent a shell which was found in the upper San Pedro series at San Pedro, and which is probably a variety of *P. ventricosus*.

Very common in the upper San Pedro series of San Pedro, Long Beach, Los Cerritos, Crawfish George's, and Deadman Island. Found also in Pleistocene on Old Mission ditch, north of Ventura, and in the Pleistocene at Twenty-sixth Street, San Diego. The specimen figured is from the upper San Pedro series at San Pedro, and is now in the collection of Delos Arnold.

*Living.*—Santa Barbara to west tropical America (Dall).

*Pleistocene.*—San Pedro; San Diego; Lower California (Hemphill; Stearns; Orcutt; and Cooper): San Pedro; Ventura; San Diego (Arnold).

Subgenus **Hinnites** *Defrance.*

Shell (up to advanced youth) a typical *Chlamys*, later becoming sessile and irregular, in which stage the resilial pit is elongated and the cardinal margin develops an obscure area.

Type, *Hinnites cortezi* Defr.

### 36. Pecten (Hinnites) giganteus *Gray.*

*Hinnites giganteus* GRAY, Ann. Phil., 1826, p. 103. CARPENTER, Brit. Assn. Rept., 1863, p. 675. GABB, Pal. Cal., Vol. II, 1869, p. 105. COOPER, 7th Ann. Rept. Cal. St. Min., 1888 p. 243. KEEP, West Coast Shells, p. 165, fig. 138, 1892. WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 193. + *H. poulsoni* CONR. = (?) *H. crassus* CON., (*fide* DALL, Trans. Wagner Inst. Sci., Vol. III, Part 4, 1898, p. 711.)

Shell large, oval, irregular, inequivalve, subequilateral; surface sculptured by about seventeen irregular, squamose, rounded, prominent radiating ridges, with two or three minor ones between each pair of the large ones.

*Dimensions.*—Long. 65 mm.; alt. 65 mm.; diam. 25 mm.

Adults distinguishable from *Pecten* on account of distortion caused by attachment to some object during the later stages of growth. The young, unattached shells of this species much resemble the young of *P. hastatus*, but are distinguishable from this species by a less spinose growth on the ribs, and also in having a much heavier shell.

Rare in upper San Pedro series of San Pedro, Los Cerritos, Crawfish George's, and Deadman Island; a few specimens from the lower San Pedro series of San Pedro.

*Living.*—Straits of Fuca to San Diego (Cooper).

*Pleistocene.*—Santa Barbara to San Diego (Cooper): San Pedro (Arnold).

*Pliocene.*—Santa Rosa Island; Ventura County; Los Angeles County (Cooper).

## Family X. LIMIDÆ.

Genus **Lima** (*Bruguière*) *Cuvier.*

Shell equivalve, compressed, obliquely oval; anterior side straight, gaping, posterior rounded, usually close; umbones apart, eared; valves white, smooth, punctate-striate, or radiately ribbed and imbricated; there is usually a thin, brownish epidermis; hinge-area triangular, cartilage pit central; adductor impression lateral, large, double; pedal scars, two, small.

*Lima squamosa* Lam. is a characteristic species.

Subgenus **Lima** *s. s.*

Hinge edentulous; valves gaping, inequilateral.

Section *Mantellum Adams.*

Submargins not impressed.

Type, *Lima hians* Gmel.

### 37. Lima (Mantellum) dehiscens *Conrad.*

*Lima dehiscens* Con., Jour. Phil. Acad. Sci., Vol. VII, 1837, p. 247, Pl. XIX, fig. 7. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 245. DALL, Trans. Wagner Inst. Sci., Vol. III, Part 4, 1898, p. 769.

*Lima orientalis* (not of AD. & RVE.) of CARPENTER, Brit. Assn. Rept., 1863, p. 645. KEEP, West Coast Shells, p. 168, fig. 142, 1892. WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 193.

Shell equivalve, compressed, obliquely oval, thin, white; anterior side straight; posterior rounded; umbones eared, posterior ears acutely pointed; surface smooth, radiately striate with fine grooves; hinge-area long, narrow, triangular; cartilage pit central, prominent; margin finely crenulated.

*Dimensions.*—Long. 13 mm.; alt. 18.5 mm.; diam. 8 mm.

Looks like an obliquely deformed *Pecten.* Specimen identified by Dr. Dall.

Rare in lower San Pedro series of Deadman Island; one specimen collected by Mrs. Oldroyd.

*Living.*—Monterey to San Diego (Cooper): Santa Catalina Island (Arnold).

*Pleistocene.*—San Pedro (Mrs. Oldroyd).

*Pliocene.*—Santa Barbara (Cooper).

## Superfamily ANOMIACEA.

## Family XI. ANOMIIDÆ.

### Genus **Pododesmus** *Philippi.*

Shell suborbicular, very variable, translucent and slightly pearly within; attached by a plug passing through a hole or notch in the right valve; a single conspicuous byssal scar on the disk; valves radiately grooved; hinge unarmed.

*Pododesmus rudis* Brod. is a characteristic species.

#### Section *Monia Gray.*

Adult hole or foramen large.

*Pododesmus machroschisma* Deshayes is a characteristic species.

### 38. Pododesmus (Monia) macroschisma *Deshayes.*

*Anomia macroschisma* DESH., REEVE, Zool. Soc. Cuvierienne, 1839, p. 359. Mag. Zool., 1841, Pl. XXXIV. MIDDENDORF, Beitr. Mal. Ross., Bd. III, 1849, p. 6. PHILIPPI, Abbild. beschr. Conch., 1850, p. 132, Pl. I, fig. 4.

*Placunanomia macroschisma* DESH., GRAY, Proc. Zool. Soc., 1849, p. 121. Cat. Anam. Brit. Mus., 1850, p. 12. CARPENTER, Brit. Assn. Rept., 1863, p. 646. TRYON, Syst. Conch., Vol. III, p. 294, Pl. CXXXI, fig. 76, 1884. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 260. KEEP, West Coast Shells, 1892, p. 163, fig. 137.

*Placunanomia (Monia) macroschisma* DESH., WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 194.

*Pododesmus (Monia) macroschisma* DESH. = *Placunanomia cepio* GRAY = *Placunanomia alope* GRAY, (*fide* DALL, Trans. Wagner Inst. Sci., Vol. III, Part 4, 1898, p. 780).

"Shell adherent, subequivalve, irregular, flattened; hinge with two thick, divergent, elongated lamella in the inferior, corresponding with two long pits in the upper valve; upper valve with only two muscular impressions; the pedal scar radiately striated"; surface with incremental laminæ and sometimes radial ridges.

Part of the above description was taken from Tryon. This species resembles *Anomia lampe*, but may be distinguished by its greater size and fewer muscle-impressions. Specimen identified by Dr. Dall.

Rare in the upper San Pedro series of San Pedro, Crawfish George's, and Deadman Island. Found also in the Pleistocene of the bluff west of the bath-house, at Santa Barbara.

*Living.*—Unalaska to San Diego; Japan (Cooper).

*Pleistocene.*—Santa Barbara to San Diego (Cooper): San Pedro (Arnold): California; Oregon; Alaska (Dall): Santa Barbara (Arnold).

*Pliocene.*—San Diego well (Dall).

*Miocene.*—Sooke, Vancouver Island (Newcombe).

### Genus **Anomia** *Linné.*

Shell suborbicular, translucent, attached by a plug passing through a hole or notch in the right valve; upper valve convex, smooth, lamellar, or striated; two byssal scars on the disk, main byssal scar largest; foramen open, ample; hinge unarmed.

*Anomia ephippium* Linné is a characteristic species.

### 39. **Anomia lampe** *Gray.*

*Anomia lampe* GRAY, Proc. Zool. Soc., 1849, p. 114. CARPENTER, Brit. Assn. Rept., 1863, p. 646. GABB, Pal. Cal., Vol. II, 1869, p. 106. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 229. KEEP, West Coast Shells, p. 163, 1892. WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 194. DALL, Trans. Wagner Inst. Sci., Vol. III, Part 4, 1898, p. 785.

Shell of medium size, suborbicular, thin, translucent and slightly pearly within; surface of left valve sculptured with fine, irregular, concentric lamellar lines and several prominent, irregular, rounded, radiating ridges; interior of this valve with submarginal cartilage pit and four muscular impressions; right or lower valve concave, with a deep rounded notch in front of the cartilage process.

*Dimensions.*—Long. and alt. 48 mm.; diam. 9 mm.

This species is variable both in regard to its shape and its sculpture, but is easily distinguishable by the thin, lamellar, translucent shell. Distinguishable from *A. limatula* Dall by its smaller size and radial ridges. Specimens identified by Dr. Dall.

Common in the upper San Pedro series of San Pedro, Los Cerritos, Long Beach, and Crawfish George's; rare in the lower San Pedro series of Deadman Island

and San Pedro. Found also in the Pleistocene at Barlow's ranch, Ventura, and in the Pleistocene of Spanish Bight and Pacific Beach, San Diego.

*Living.*—Monterey to Mexico (Cooper).

*Pleistocene.*—San Pedro (Cooper; Arnold): Ventura; San Diego (Arnold).

### [S. D.] **Anomia limatula** *Dall.*

*Anomia limatula* DALL, Proc. U. S. Nat. Mus., Vol. I, 1879, p. 15. Trans. Wagner Inst. Sci., Vol. III, Part 4, 1898, p. 785, Pl. XXXV, fig. 19.

Shell large, thin, irregular, with a rather thickened hinge-line; external surface rough, like fresh fractured china-ware; surface devoid of all normal radial sculpture, and still retaining on its yellowish valves traces of dark purple, irregularly radial blotches. The calcareous plug of this species is peculiar, being hollow, and the cylinder incomplete on one side.

Distinguishable from *A. lampe* and *Pododesmus macroschisma* by its lack of radial sculpture. Reported in the Pleistocene of San Pedro by Stearns.

*Pleistocene.*—San Pedro (Stearns): Ventura County, eight miles inland and two hundred feet elevation above sea-level (Bowers): Spanish Bight and Coronado Beach, San Diego (Hemphill; Stearns): Twenty-sixth Street, San Diego (Hemphill; Arnold).

## Superfamily MYTILACEA.

## Family XII. MYTILIDÆ.

### Genus **Mytilus** (*Linné*) *Bolten.*

Shell wedge-shaped, rounded behind; umbones terminal, pointed; hinge-teeth minute or obsolete; pedal muscular impressions two in each valve, small, simple, close to the adductors.

*Mytilus smaragdinus* Chemn. is a characteristic species.

#### Section *Mytilus s. s.*

Surface with chiefly concentric sculpture, or smooth.

Type, *Mytilus edulis* Linné.

### 40. **Mytilus edulis** *Linné.*

*Mytilus edulis* LINN., Syst. Nat., Ed. X, 1758, p. 705. = *M. borealis* LAM. = *M. abbreviatus* LAM. = *M. vetustus* LAM. = *M. incurvatus* LAM. = *M. pellucidus* PENNANT = *M. notatus* DEKAY = *M. subsaxatilis* WILLIAMSON (*fide* CARPENTER, Brit. Assn. Rept., 1856, p. 219). CARPENTER, Brit. Assn. Rept., 1863, p. 643. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 252. KEEP, West Coast Shells, p. 173, 1892. WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 191. = *Modiola pulex* H. C. LEA (not of LAM.) = *Mytilus minganensis* MIGHELS, &c. (*fide* DALL, Wagner Inst. Sci., Vol. III, Part 4, 1898, p. 788).

*Mytilus pedroanus* CON., Pac. R. R. Rept., Vol. V, 1853, p. 325, Pl. V, fig. 40.

Shell of medium size, wedge-shaped, rounded behind, thin; surface smooth, except for concentric, incremental lines; umbones terminal; dorsal margin slightly depressed in middle; hinge-teeth minute.

*Dimensions.*—Long. 55 mm.; lat. 24 mm.; diam. 18 mm.

The only difference between the Pleistocene specimens and the living form is in the coloration of the epidermis, that of the former being reddish brown, while the latter is blue. Specimens identified by Dr. Dall.

Rare in the lower San Pedro series of Deadman Island; and in the upper San Pedro series of Deadman Island, Crawfish George's, and San Pedro.

*Living.*—San Pedro (Williamson): Monterey, north; Japan; circumpolar (Cooper): Atlantic Ocean south to North Carolina (Dall).

*Pleistocene.*—Benicia, Solano County (Cooper): San Pedro (Arnold): Atlantic coast from Labrador to St. John's River, Florida; northern Europe; northwest coast of America (Dall).

*Pliocene.*—Red Crag, Great Britain (Dall).

### Genus **Septifer** *Recluz.*

Shell equivalve, very inequilateral; ventral margin subconcave and cut out for the passage of the byssus; beaks subterminal, curved; hinge without teeth, furnished with a lamellar septum; ligamental pits linear, marginal, dorsal, anterior, with a white, nearly spongy margin within; muscular impressions superficial, the anterior small, rounded, the posterior large, subdorsal, uniform.

*Septifer heberti* Desh. is a characteristic species.

### 41. **Septifer bifurcatus** *Conrad.*

*Mytilus bifurcatus* CONRAD, Journ. Phil. Acad. Sci., Vol. VII, 1837, p. 241, Pl. XVIII, fig. 14. REEVE, Conch. Icon., Pl. IX, fig. 41.

*Septifer bifurcatus* RVE., CARPENTER, Brit. Assn. Rept., 1863, p. 643. GABB, Pal. Cal., Vol. II, 1869, p. 101. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 264. KEEP, West Coast Shells, p. 171, fig. 144, 1892. WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 191. DALL, Trans. Wagner Inst. Sci., Vol. III, Part 4, 1898, p. 789.

Shell small, wedge-shaped, equivalve, convex, rather thick; beaks pointed, terminal; surface sculptured by numerous strong, rounded, terminally bifurcating, radiating ridges, and fine concentric, incremental sulcations; margin corrugated; a small lamellar deck stretches across the interior of the shell near the umbo; teeth small.

*Dimensions.*—Beak to ventral margin 10 mm.; lat. 6 mm.; diam. 4 mm.

This little shell is shaped like a *Mytilus edulis*, but is smaller and has prominent, bifurcating, radiating ridges, delicate incremental sculpture, and an umbonal deck.

Rare in the lower San Pedro series at Deadman Island.

*Living.*—Farallon Islands to San Diego (Cooper).

*Pleistocene.*—Santa Barbara; San Diego (Cooper): San Pedro (Arnold).

### Genus **Modiolus** *Lamarck.*

Shell oblong, inflated in front; umbones anterior obtuse; hinge toothless; pedal impressions three in each valve, the central elongated; epidermis often produced into long beard-like fringes.

Type, *Mytilus modiolus* Linné.

### Section *Modiolus s. s.*

Surface smooth, shell inflated, edentulous, epidermis more or less hirsute.

Type, *Mytilus modiolus* Linné.

#### 42. **Modiolus fornicatus** *Carpenter.*

*Modiola fornicata* CPR., Brit. Assn. Rep., 1863, p. 643; Ann. & Mag. Nat. Hist., 3rd Ser., Vol. XV, 1865, p. 179. KEEP, West Coast Shells, p. 173, 1892. WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 191.

Shell of medium size, short, oblong, inflated in front, swollen, equivalve; beaks anterior, not quite terminal, obtuse, marginal, bent forward; surface sculptured only with concentric incremental lines; margins smooth; no hinge teeth.

*Dimensions.*—Beaks to ventral margin 54 mm.; lat. 31 mm.; diam. 30 mm.

This species is distinguishable by its short, swollen form.

Rare in the lower San Pedro series of Deadman Island, and in the upper San Pedro series of Los Cerritos. Found also in the Pleistocene of Barlow's ranch, Ventura, and bluff west of bath-house, Santa Barbara.

*Living.*—Monterey to Santa Barbara (Carpenter): San Pedro (Williamson).

*Pleistocene.*—San Pedro (Arnold): Ventura; Santa Barbara (Arnold).

#### 43. **Modiolus rectus** *Conrad.*

*Modiola recta* CON., Journ. Acad. Nat. Sci. Phil., Vol.VII, 1837, p. 243, pl. XIX, fig. 1. CARPENTER, Brit. Assn. Rept., 1863, p. 643. GABB, Pal. Cal. Vol. II, p. 101, 1869. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 251. KEEP, West Coast Shells, p. 171, fig. 145, 1892. WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 192. DALL, Trans. Wagner Inst. Sci., Vol. III, Part. 4, 1898, p. 793.

Shell large, rhomboidal, narrow, evenly convex, not sharply ridged, sculptured by numerous fine, concentric, incremental lines; lower margin a nearly straight line; ligament long, narrow, straight.

*Dimensions.*—Long. 150 mm.; alt. 50 mm.; diam. 38 mm.

Specimen identified by Dr. Dall.

Rare in lower San Pedro series of Deadman Island, and the upper San Pedro series of Deadman Island, San Pedro, and Los Cerritos. Found also in the Pliocene of Pacific Beach, and the Pleistocene of Pacific Beach and Twenty-sixth Street, San Diego.

*Living.*—Santa Cruz to San Diego (Cooper).

*Pleistocene.*—San Pedro (Cooper, Arnold): San Diego (Arnold).

*Pliocene.*—Santa Rosa; Twelve Mile House, San Mateo County; Soquel, Santa Cruz County; San Fernando; San Diego well (Cooper): San Diego (Arnold).

*Miocene.*—El Toro Ranch, Monterey County; Foxin's, Santa Barbara County (Cooper).

### Genus **Lithophaga** *Bolten.*

Shell cylindrical, inflated in front, wedge-shaped behind; epidermis thick and dark; interior nacreous.

Type, *Mytilus lithophagus* Linné.

#### 44. **Lithophaga plumula** *Hanley.*

*Lithophagus plumula* HANLEY, CARPENTER, Brit. Assn. Rept., 1863, p. 644. KEEP, West Coast Shells, p. 171, 1892. WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 192.
*Lithophaga plumula* HANLEY, DALL, Trans. Wagner Inst. Sci., Vol. III, Part. 4, 1898, p. 799.

Shell subcylindric, with nearly terminal beaks; two radial sulci extending backward from the beaks, incrustation plume-like, arranged in a distinct pattern on the areas between the sulci, and, when projecting beyond the ends of the valve, apposited symmetrically.

One perfect cast of a shell of this species was found on the inside of a *Metis alta* in the upper San Pedro series at Los Cerritos.

*Living.*—Monterey to San Diego (Carpenter).

*Pleistocene.*—San Pedro (Arnold).

## Order ANOMALODESMACEA.

## Superfamily ANATINACEA.

## Family XIII. PERIPLOMIDÆ.

### Genus **Periploma** *Schumacher.*

Shell oval, very inequivalve, inequilateral, slightly nacreous; left valve deepest; posterior side very short and contracted; hinge with a narrow, oblique, spoon-shaped process in each valve, and a small triangular ossicle; an internal rib proceeds from under the hinge to the posterior margin; muscular impressions unequal, the anterior long and narrow, the posterior small, semilunar; pallial impression marginal.

*Periploma inæquivalvis* Schum. is a characteristic species.

#### 45. **Periploma argentaria** *Conrad.*

*Periploma argentaria* CON., Journ. Phil. Acad. Sci., Vol. VII, 1837, p. 238, Pl. XVIII, fig. 8. CARPENTER, Proc. Zool. Soc., 1856, p. 211; Brit. Assn. Rept., 1863, p. 638. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 258. KEEP, West Coast Shells, p. 204, fig. 175, 1892. DALL, mss., 1900.

*Periploma planiuscula* SBY. + *P. lenticularis* SBY. = *P. argentaria* CON. = *P. alta* C. B. AD. = *P. excurva* CPR. (*fide* STEARNS, Proc. U. S. Nat. Mus., Vol. XIII, 1890, p. 223). DALL, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 184.

Shell of medium size, elliptical, inequilateral, inequivalve, fragile; umbones small, anterior to center; posterior extremity long and evenly rounded, but produced farthest a little above the middle; anterior portion much shorter than posterior, faintly biangulated; surface sculptured by fine concentric, incremental lines; hinge a hollow spoon-shaped process, projecting inwards from below the umbones; this cartilage process is strengthened by an elongated callus slanting anteriorly; pallial sinus short, cuneiform.

*Dimensions.*—Long. 46 mm.; alt. 33 mm.; diam. 18 mm.; umbo to anterior extremity 13 mm.; to posterior extremity 33 mm.

Specimens identified by Dr. Dall.

Rare in the San Pedro series of San Pedro, Los Cerritos, Crawfish George's, and Deadman Island. Found also in the Pleistocene at Twenty-sixth Street and Spanish Bight, San Diego.

*Living.*—Point Conception south to Mexican coast (Stearns).

*Pleistocene.*—San Pedro (Arnold): San Diego (Cooper, Arnold.)

## Family XIV. THRACIIDÆ.

### Genus **Thracia** *(Leach) Blainville.*

Shell oblong, nearly equivalve, slightly compressed, attenuated and gaping posteriorly; smooth or minutely scabrous; cartilage process thick, not prominent, with a crescentic ossicle; pallial sinus shallow.

*Thracia pubescens* Pult. is a characteristic species.

### 46. **Thracia trapezoides** *Conrad.*

*Thracia trapezoides* CON., Wilkes Exped., Vol. X, 1849, p. 723, Pl. XVII, fig. 6. GABB, Pal. Cal., Vol. II, 1869, p. 90. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 267.

Shell of medium size, subtrigonal, compressed, thin; umbones central, bent slightly posteriorly; anterior margin evenly arcuate from umbones, bending off quite evenly into the arcuate ventral margin; anterior extremity most produced near base; posterior dorsal margin depressed near umbo, sloping off slightly concavely to a line which abruptly truncates the posterior extremity; this truncating line is slightly arcuate, but is angular at both ends; surface sculptured by faint incremental lines; a prominent fold runs from the umbones to the lower part of the truncated extremity.

*Dimensions.*—Long. 48 mm.; alt. 38 mm.; diam. 16 mm.

After comparing the San Pedro Pliocene specimens with several Miocene shells from the Astoria horizon of Blakely, Washington (Conrad's type came from this same horizon), it is evident that the two forms are identical. The San Pedro specimens, however, average much larger in size. Dr. Dall labeled these specimens "*Thracia? curta.*" *T. curta* is much less depressed behind the beaks, has a much

straighter ventral margin, and a more evenly rounded anterior extremity than *T. trapezoides*.

This species is found in only one narrow stratum of the San Pedro Pliocene. This stratum outcrops near the base of Deadman Island, and also on the top of the ridge at the head of the railroad grade in the southeastern part of San Pedro. It is the predominating species in this one stratum.

*Pliocene.*—Eagle Prairie, Humboldt County (Cooper): San Pedro (Arnold).

*Miocene.*—Oregon (Cooper): Blakely, near Seattle, Washington (Arnold).

## Family XV. PANDORIDÆ.

### Genus **Pandora**.

Shell inequivalve, thin, pearly inside; valves close, attenuated behind; right valve flat, with a diverging ridge and cartilage furrows; left valve convex, with two diverging grooves at the hinge; pallial line slightly sinuated.

### Subgenus **Kennerlia** *Carpenter*.

Hinge ossicle thin; radiating ribs on the right valve.

Type, *Kennerlia bicarinata* Carpenter.

#### 47. **Pandora (Kennerlia) bicarinata** *Carpenter*.

PLATE XVIII, FIG. 2.

*Kennerlia bicarinata* CPR., Brit. Assn. Rept., 1863, p. 638; Proc. Zool. Soc., 1864, p. 603. TRYON, Syst. Conch., Vol. III, 1884, p. 143.

*? Pandora bilirata* CON., COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 257.

Shell small, planoconvex, oval, thin; umbones minute, about one-third length from anterior end; anterior and posterior dorsal margins straight, making an angle a little less than 160 degrees at the umbo; ventral margin arcuate, rounding upward at each end and meeting dorsal margins in angulated turns; two posterior submarginal ridges run from the umbo to the extremity in the convex valve; surface sculpture and hinge as in *K. filosa*.

*Dimensions.*—Long. 14 mm.; alt. 9 mm.; diam. 3 mm.; umbones to anterior extremity 4 mm.; to posterior extremity 10 mm.

This species is closely related to *K. filosa*, but is distinguishable by its broader, shorter shell, rounded rather than beaked posterior extremity, and more nearly central umbones. Probably the same as *Pandora bilirata* of Conrad.

One left valve from the lower San Pedro series of Deadman Island, which is figured, and is now in the possession of Delos Arnold.

*Living.*—Catalina Island (Carpenter).

*Pleistocene.*—San Pedro (Arnold): Santa Barbara (Cooper).

### 48. Pandora (Kennerlia) filosa *Carpenter.*

PLATE XVIII, FIG. 3.

*Kennerlia filosa* CPR., Brit. Assn. Rept., 1863, p. 638; Proc. Zool. Soc., 1864, p. 602.

Shell small, planoconvex, elongate-oval, thin; umbones minute, about one-fourth length from anterior extremity; anterior and posterior dorsal margins straight, making an angle of 160 degrees at the umbo; ventral margin arcuate; posterior extremity long, narrowed and truncated at the end; anterior rounded up from base but making an angle with dorsal margin; a single prominent posterior, submarginal ridge runs from umbo to extremity on each valve, being nearer the margin in the flat valve; surface of both valves sculptured by numerous fine, concentric, incremental lines, and that of the right valve by fine radiating sulcations; left valve with a thin hinge ossicle; right valve with two ossicles, the anterior one being short.

*Dimensions.*—Long. 16 mm.; alt. 7 mm.; diam. 3 mm.; umbo to anterior end 4 mm.; to posterior end 12 mm.

The right valve of this little shell looks something like a wing, and resembles *Clidiophora punctata*, but is distinguishable by the straight dorsal margin, radiating sulcations, and narrower form.

Specimens identified by Dr. Dall.

One right and one left valve found in the lower San Pedro series of Deadman Island. The specimen figured is from the lower San Pedro series at Deadman Island, and is now in the collection of Delos Arnold.

*Living.*—Puget Sound (Carpenter).

*Pleistocene.*—San Pedro (Arnold).

## Genus **Clidiophora** *Carpenter.*

Shell inequivalve, thin, pearly inside; valves close, attenuate behind; right valve rather tumid, with three hinge teeth, the posterior one elongated; left valve often with two teeth; ossicle present; pallial line simple.

*Clidiophora claviculata* Carp. is a characteristic species.

### 49. Clidiophora punctata *Conrad.*

*Pandora punctata* CON., Journ. Phil. Acad. Sci., Vol. VII, 1837, p. 228, Pl. XVII, fig. 1.
*Clidiophora punctata* CON., CPR., Brit. Assn. Rept., 1863, p. 638. CPR., Proc. Zool. Soc., 1864, p. 598. GABB, Pal. Cal., Vol. II, p. 90, 1869. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 235. WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 183.

Shell rather small, suboval, much compressed, thin; umbo posterior to center, marginal, not elevated; anterior dorsal margin concavely arcuate; anterior extremity rostrated; posterior extremity evenly rounded; outer surface sculptured with fine, concentric, incremental lines; interior pearly, punctate; right valve slightly tumid, with three hinge teeth; left valve with two hinge teeth.

*Dimensions.*—Long. 30 mm.; alt. 19.5 mm.; diam. 5 mm.; umbo to anterior end 21 mm.; to posterior end 9 mm.

Specimens identified by Dr. Dall.

Rare in the lower San Pedro series of Deadman Island and upper San Pedro series of San Pedro. Found also at Spanish Bight, San Diego.

*Living.*—Straits of Fuca to San Diego (Cooper).

*Pleistocene.*—San Pedro (Arnold): San Diego (Arnold).

*Pliocene.*—San Benito County (Cooper).

*Miocene.*—Ventura County (Cooper).

## Family XVI. LYONSIIDÆ.

### Genus **Lyonsia** *Turton.*

Shell nearly equivalve, left valve largest; thin, subnacreous, close, truncated posteriorly; cartilage plates oblique, covered by an oblong ossicle; pallial sinus obscure, angular.

*Lyonsia norvegica* is a characteristic species.

#### 50. **Lyonsia californica** *Conrad.*

*Lyonsia californica* CON., Journ. Phil. Acad. Sci., Vol. VII, 1837, p. 248, Pl. XIX, fig. 20. CPR., Proc. Zool. Soc., 1856, p. 210; =*L. bracteata* GLD. =*L. nitida* GLD., (*fide* CARPENTER, Brit. Assn. Rept., 1863, p. 638). KEEP, West Coast Shells, p. 202, fig. 174, 1892. WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 184.

Shell of medium size, elongate-oval, truncated and narrowing slightly posteriorly, convex, thin; long, slightly depressed posterior to umbo; short, convex anterior; surface sculptured with fine, concentric, incremental lines; external layer chalky and fugacious, pearly beneath; cartilage-plates oblique, covered by an oblong ossicle; pallial sinus obscure.

*Dimensions.*—Long. 31 mm.; alt. 14 mm.; diam. 11 mm.

This frail shell is generally found with the outer layer gone, leaving the pearly surface of the lower layer exposed. Outline variable.

Specimens identified by Dr. Dall.

Rather common in the Pliocene of Deadman Island, the lower San Pedro series of Deadman Island and San Pedro, and the upper San Pedro series of Deadman Island, Crawfish George's, and San Pedro.

*Living.*—Puget Sound to San Diego (Carpenter).

*Pleistocene.*—San Pedro (Arnold).

*Pliocene.*—San Pedro (Arnold).

### Genus **Mytilimeria** *Conrad.*

Shell rounded oval, more or less ventricose, equivalve, fragile, covered by a thin caducous epidermis; beaks subspiral; hinge without teeth, but formed of small linear excavations under the beaks to receive the ligament, which contains a small ossicle; muscular impressions small; pallial impression with an obtuse sinus.

Type, *Mytilimeria nuttalli* Conrad.

### 51. Mytilimeria nuttalli *Conrad.*

PLATE XVII, FIG. 8.

*Mytilimeria nuttalli* CON., Journ. Phil. Acad. Sci., Vol. VII, 1837, p. 247. CPR., Brit. Assn. Rept., 1863, p. 638. GABB, Pal. Cal., Vol. II, p. 90, 1869. TRYON, Syst. Conch., Vol. III, 1884, p. 147, Pl. CVIII, fig. 68. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 252. KEEP, West Coast Shells, p. 203, 1892.

Shell small, equivalve, suboval, convex, thin; beaks central, subspiral, small; surface sculptured by fine, concentric, incremental lines and numerous delicate radiating sulcations, the whole having a pearly luster; hinge edentulous, with a slight linear cavity under the beaks; pallial sinus broad, obtuse.

*Dimensions.*—Long. 11 mm.; alt. 17 mm.; diam. 10 mm.

This fragile little shell resembles a very small and broad *Mytilus*, but is easily distinguishable by its delicate sculpture. Specimens identified by Dr. Dall.

Rare in the Pliocene and lower San Pedro series of Deadman Island, and in the lower San Pedro series of San Pedro.

The species figured is imperfect. It came from the lower San Pedro series at Deadman Island, and is now in the collection of Delos Arnold.

*Living.*—Straits of Fuca to San Diego (Cooper).

*Pleistocene.*—San Pedro (Cooper; Arnold).

*Miocene.*—Tomales, Marin County (Cooper).

## Superfamily POROMYACEA.

## Family XVII. VERTICORDIIDÆ.

### Genus **Verticordia** *S. Wood.*

Shell suborbicular, with radiating ribs; beaks subspiral; margins denticulated; interior brilliantly pearly; hinge with one prominent cardinal tooth in each valve; adductor scars two, faint; pallial line simple; ligament internal, oblique; epidermis dark brown.

Type, *Verticordia cardiiformis* Wood.

### 52. Verticordia novemcostata *Adams & Reeve.*

PLATE XVII, FIG. 10.

*Verticordia novemcostata* AD. & RVE. = *V. ornata* D'ORB. (*fide* CPR., Brit. Assn. Rept., 1863, p. 645.)

Shell small, suborbicular, compressed, thin; beaks subcentral, subspiral, small, sharp, anterior extremity evenly rounded; posterior dorsal margin evenly arcuate, and joining arcuate ventral margin in an angular extremity; surface with nine prominent, sharp, arcuate, radiating ridges; the first and third interspaces wider than the others; margins sharply denticulate; hinge with one prominent cardinal tooth in each valve; adductor scars two, faint; pallial line simple; ligament internal, oblique; interior pearly.

*Dimensions.*—Long. 4 mm.; alt. 3.5 mm.; diam. 2 mm.

This little shell is one of the unique species of this fauna. Specimens identified by Dr. Dall.

One specimen from lower San Pedro series of Deadman Island, which is figured, and is now in the collection of Delos Arnold.

*Living.*—Santa Barbara; Samarang, China; South America (Carpenter): San Pedro (Raymond).

*Pleistocene.*—San Pedro (Arnold).

## Order TELEODESMACEA.

## Superfamily ASTARTACEA.

### Family XVIII. ASTARTIDÆ.

#### Genus **Astarte** *Sowerby.*

Shell suborbicular, compressed, thick, smooth, or concentrically furrowed; lunule compressed; ligament external; epidermis dark; hinge-teeth two in each valve, the anterior tooth of the right valve large and thick; anterior pedal scar distinct; pallial line simple.

*Astarte semisulcata* Leach is a characteristic species.

#### Subgenus **Crassinella** *Bayle.*

Shell obliquely lengthened, subquadrangular.

*Astarte obliqua* Desh. is a characteristic species.

**53. Astarte (Crassinella) branneri**, sp. nov.

PLATE XVIII, FIG. 12.

Shell small, subtrigonal, equivalve, inequilateral, convex, thick; umbo small, sharp; anterior dorsal margin straight to anterior extremity, where it meets the arcuate ventral margin in an angle; posterior dorsal margin evenly arcuate, sloping down to rounded, posterior extremity; surface sculptured with numerous angular, concentric undulations or ridges; lunule long, narrow, extending to anterior extremity, and circumscribed by a narrow, angular ridge; ligament external, not prominent; two prominent cardinal teeth in right valve; one in left; no laterals; pallial line entire, running from the middle of adductor scars; adductor scars subequal, small.

*Dimensions.*—Long. 10 mm.; alt. 8.9 mm.; diam. 5 mm.

This species somewhat resembles *Astarte compacta* Cpr., but has a longer lunule, finer concentric ridges, and is more bilaterally symmetrical. Specimens pronounced a new species by Dr. Dall. Named in honor of Dr. John C. Branner, Professor of Geology, Leland Stanford Junior University.

Rare in the upper San Pedro series of San Pedro and Los Cerritos. The specimen figured is the type, which is from the upper San Pedro series at Los

Cerritos, and is now in the United States National Museum. Found also in the Pleistocene of Twenty-sixth Street, San Diego.

*Pleistocene.*—San Pedro; San Diego (Arnold).

## Superfamily CARDITACEA.

## Family XIX. CARDITIDÆ.

### Genus **Venericardia** *Lamarck.*

Shell suborbicular, inequilateral, radiately ribbed; hinge with two oblique cardinal teeth and no laterals.

*Venericardia planicostata* Lamarck is a characteristic species.

### 54. **Venericardia barbarensis** *Stearns.*

*Venericardia barbarensis* STEARNS, Proc. U. S. Nat. Mus., Vol. XIII, 1891, p. 214, Pl. XVI, figs. 3, 4.

Shell rounded, inequilateral, variable in outline, more or less oblique, moderately convex; beaks small, slightly elevated and turned forward; surface ornamented with nineteen or twenty radiating ribs, usually somewhat granulose; lunule small, slightly sunken, faintly defined; hinge-line small, not thick; hinge composed of, in left valve, a single strong cardinal sloping posteriorly and a smaller tooth, often obscure, slanting anteriorly; a third tooth-like process is generally present, situated under, and apparently a projection of, the edge of the lunule; the right valve has a single strong cardinal tooth with a slanting, somewhat sinuous groove above and a slight notch and tooth-like point below the upper part of the lunule; muscle impressions small.

*Dimensions.*—Long. 19.5 mm.; alt. 17 mm.; diam. 14 mm.

Distinguishable from *V. ventricosa* by more subrectangular outline, greater relative length; greater number of ribs, less prominent beak, much narrower and longer hinge-line, and shorter, slighter posterior cardinal tooth, which is straight.

Common in Pliocene and lower San Pedro series of Deadman Island; rare in Pliocene at Timm's Point and upper San Pedro series of Crawfish George's and San Pedro. Found also west of bath-house at Santa Barbara.

*Living.*—Santa Barbara Islands (276 fathoms) (Stearns).

*Pleistocene.*—San Pedro (Arnold): Santa Barbara (Arnold).

*Pliocene.*—San Pedro (Arnold).

### 55. **Venericardia ventricosa** *Gould.*

*Cardita ventricosa* GLD., Proc. Bost. Soc. Nat. Hist., 1850, p. 276; Wilkes Expl. Exped., Vol. XII, p. 417, Pl. XXXVI, fig. 532, 1852, =*C. subtenta* CON., =*C. monilicosta* GABB, =*C. occidentalis* CON., (*fide* GABB, Pal. Cal., Vol. II, 1869, p. 100).

*Venericardia borealis* var. *ventricosa* GLD., CPR., Brit. Assn. Rept., 1863, p. 643. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 269.

*Venericardia ventricosa* GLD., STEARNS, Proc. U. S. Nat. Mus., Vol. XIII, 1891, p. 216, Pl. XVI, figs. 5 and 6. WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 190.

Shell small, subcircular, ventricose, thick; umbones slightly anterior to center, much bent forward, prominent; surface sculptured by about thirteen prominent, rounded, radiating ridges, which are slightly roughened by regular lines of growth; sulcations narrow; hinge area broad, short; two prominent teeth in each valve, anterior short; margin closely crenulated.

*Dimensions.*—Long. 12.5 mm.; alt. 13 mm.; diam. 8 mm.

Distinguishable by small size, coarse sculpture and heavy hinge. Common in the Pliocene of Deadman Island and Timm's Point; rare in lower San Pedro series of Deadman Island. Found also in Pleistocene of Pacific Beach, near San Diego; and in the Pliocene of Packard's Hill and the Pleistocene near the bath-house, Santa Barbara.

*Living.*—Alaska to Catalina Island (Cooper).

*Pleistocene.*—Santa Barbara to San Diego (Cooper): San Pedro; Santa Barbara; San Diego (Arnold).

*Pliocene.*—San Fernando; Santa Barbara to San Diego (Cooper): San Pedro; Santa Barbara (Arnold).

*Miocene.*—Oregon; Foxin's, Santa Barbara County; Santa Monica (Cooper): Blakeley, near Seattle, Washington (Arnold).

### Genus **Lazaria** *Conrad.*

Shell transverse, oblong, inequilateral; beaks subanterior, radiately ribbed; hinge with two cardinal and two lateral diverging teeth in each valve, the posterior teeth being in each case much elongated, the anterior short and more or less pointed, sublunular.

*Lazaria pectunculus* Brug. is a characteristic species.

### 56. **Lazaria subquadrata** *Carpenter.*

*Lazaria subquadrata* CPR., Brit. Assn. Rept., 1863, p. 642; Ann. Mag. Nat. Hist., 3d ser., Vol. XV, 1865, p. 179. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 244. KEEP, West Coast Shells, p. 179, fig. 152, 1892. WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 190.

Shell small, transverse, subrectangular, inequilateral, ventricose, thick; beaks subanterior, not prominent; dorsal posterior margin long, straight; anterior portion abruptly truncated just in front of beak; surface sculptured with heavy, squamose, rounded, radiating ridges; interior margin coarsely crenulated; hinge with two lateral diverging teeth in each valve, the posterior teeth being in each case much elongated, the anterior short and pointed.

*Dimensions.*—Long. 10 mm.; alt. 6 mm.; diam. 5.6 mm.

Distinguishable by its small size, rectangular outline, and coarse, squamose ridges which radiate from one corner of the rectangle. Specimens identified by Dr. Dall.

Rare in the lower San Pedro series of Deadman Island and San Pedro; and in the upper San Pedro series of Crawfish George's and San Pedro.

*Living.*—Straits of Fuca to San Diego (Cooper).

*Pleistocene.*—Santa Barbara (Cooper): San Pedro (Arnold).

## Superfamily CHAMACEA.

## Family XX. CHAMIDÆ.

### Genus **Chama** (*Pliny*) *Linné.*

Shell attached usually by the left umbo; valves foliaceous; the upper smallest; hinge-tooth of free valve thick, curved, received between two teeth in the other; adductor impressions large; oblong, the anterior encroaching on the hinge-tooth.

*Chama lazarus* Linné is a characteristic species.

#### 57. **Chama exogyra** *Conrad.*

*Chama exogyra* CON., Jour. Phil. Acad. Sci., Vol. VII, 1837, p. 256. REEVE, Conch. Icon., sp. 38, Pl. VII. CARPENTER, Proc. Zool. Soc., 1856, p. 217; Brit. Assn. Rept., 1863, p. 641. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 233; Bull. Cal. St. Min. Bureau, No. 4, 1894, p. 24. KEEP, West Coast Shells, p. 182, 1892. WILLIAMSON, U. S. Nat. Mus., Vol. XV, 1892, p. 189.

Shell of medium size, oval, irregular; left valve subcompressed, thick, attached when living; umbo small, submarginal, much twisted, either dextral or sinistral, generally the former; surface foliated with irregular, disconnected, rough, translucent, concentric frills; hinge-tooth thick in free valve; two teeth in attached valve; adductor impressions large, oblong, the anterior encroaching on the hinge-tooth.

*Dimensions.*—Long. 33 mm.; alt. 33 mm.; diam. 16 mm.

Distinguishable from *C. pellucida* by larger, thicker shell, fewer and less spiny, though more prominent frills; and by being attached generally by the left valve. Specimens identified by Dr. Dall.

Rare in upper San Pedro series of San Pedro and Los Cerritos.

*Living.*—Bodega Bay to San Diego; Mexico (Cooper).

*Pleistocene.*—Santa Barbara to San Pedro (Cooper): San Pedro (Arnold): San Nicolas Island (Bowers).

#### 58. **Chama pellucida** *Sowerby.*

*Chama spinosa* BROD. var. *pellucida* SBY., Proc. Zool. Soc., 1834, p. 150.

*Chama pellucida* SBY., CPR., Brit. Assn. Rept., 1863, p. 641. KEEP, West Coast Shells, p. 182, fig. 155, 1892. WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 189. COOPER, Bull. Cal. St. Min. Bureau, No. 4, 1894, p. 24.

Shell of medium size; right valve (attached), exceedingly ventricose, rather thin; left valve nearly flat, thicker; surface of attached valve sculptured with numerous prominent, spiny frills; surface of upper valve with more numerous, small frills, which are sometimes spiny near the margin of the valve; hinge-teeth and muscle-impressions as in *C. exogyra.*

*Dimensions.*—Long. 20 mm.; alt. 25 mm.; diam. 15 mm.

Distinguishable from *C. exogyra* by smaller size, more prominent frills on upper valve, and by the fact that in *C. pellucida* the right valve is generally attached, and is exceedingly ventricose, while in *C. exogyra* the left valve is the larger, and is attached. Specimens identified by Dr. Dall.

Rather common in the Pliocene; rarer in the lower San Pedro series of Deadman island; and only found occasionally in the upper San Pedro series of San Pedro, Deadman Island, Los Cerritos, and Crawfish George's.

*Living.*—San Francisco to San Diego (Carpenter).

*Pleistocene.*—San Pedro (Arnold).

*Pliocene.*—Ventura County (Bowers).

## Superfamily LUCINACEA.

### Family XXI. LUCINIDÆ.

#### Genus **Lucina** *Brugière.*

Shell orbicular, white; umbones depressed; lunule distinct; margins smooth or minutely crenulated; ligament oblique, semi-internal; hinge-teeth two in each valve; laterals, two in right valve, four in left; muscular impressions rugose; anterior elongated within the pallial line, posterior oblong; umbonal area with an oblique furrow.

*Lucina jamaicensis* Linné is a characteristic species.

#### 59. **Lucina acutilineata** *Conrad.*

*Lucina acutilineata* CON., Wilkes Expl. Exped., Vol. X, p. 725, Pl. XVIII, fig. 2, 1849.
*Cyclas acutilineata* CON., Jour. Conch., 1865, p. 153.
*Lucina borealis* (not of LINNÆUS, Syst. Nat., Edition XII, p. 1413); of CPR., Brit. Assn. Rept., 1863, p. 643; = *Pectunculus patulus* CON., Jour. Conch., 1865, p. 153; not Wilkes Expl. Exped., p. 726. Pl. XVIII, fig. 9; = *Lucina tetrica* CON. (*fide* GABB, Pal. Cal., Vol. II, p. 100, 1869). COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 246.

Shell large, orbicular, only slightly convex, rather thin; umbones depressed, central; surface ornamented by numerous equal, equidistant, sharp, raised, concentric lines; interspaces show lines of growth; lunule small, but deeply impressed and distinct; two sharp cardinal teeth in each valve; lateral teeth nearly obsolete; anterior muscle-impression much elongated.

*Dimensions.*—Long. 57 mm.; alt. 53 mm.; diam. 28 mm.

This species is easily distinguishable by its large size and sharp, concentric, raised lines. This beautiful shell is always found in a fine state of preservation in the Deadman Island formations, in many cases occurring in pairs. The shell is translucent, and in only a few instances have imperfect specimens been found. The convexity of the shell is slightly variable, being more in the younger shells, the older ones being inclined to become flatter. The Pliocene specimens are smaller, more convex, and have the concentric lines much closer set than do the Pleistocene forms. Specimens identified by Dr. Dall.

Common in Pliocene and lower San Pedro series of Deadman Island and San Pedro; rare in the upper San Pedro series of Deadman Island, Crawfish George's, and San Pedro. Only one or two specimens have been found in each of the upper San Pedro localities; thus practically restricting the northern species to the Pliocene and

lower San Pedro series. Found also in the Pleistocene west of bath-house, Santa Barbara; and in the Pleistocene of Pacific Beach, San Diego.

*Living.*—Catalina Island (Cooper): Santa Barbara channel (Carpenter): Puget Sound (Arnold).

*Pleistocene.*—Santa Barbara to San Diego (Cooper): San Pedro; Santa Barbara; San Diego (Arnold).

*Pliocene.*—Santa Rosa; Santa Cruz; Sargent's, Santa Clara County; Santa Barbara; San Fernando; San Diego well (Cooper): Stanford University (Arnold).

*Miocene.*—Oregon; Martinez; Griswold's, San Benito County; Orestima Canyon, Stanislaus County; Foxin's, Santa Barbara County (Cooper): Point Blakely, near Seattle, Washington (Arnold).

### 60. Lucina californica *Conrad.*

*Lucina californica* CON., Jour. Phil. Acad. Sci., Vol. VII, 1837, p. 255, Pl. XX, fig. 1. CPR., Brit. Assn. Rept., 1863, p. 642. GABB, Pal. Cal., Vol. II, 1869, p. 100. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 247. KEEP, West Coast Shells, p. 178, fig. 151, 1892. WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 190.

Shell of medium size, orbicular, only slightly convex, rather thick; umbones depressed, central; surface ornamented with numerous fine, close-set, sharp, concentric lines and very faint, fine, radiating striæ; lunule small but distinct, deep-set, wholly in right valve; ligament prominent; two cardinal teeth in each valve; two prominent anterior, lateral teeth in left valve, one in right valve, other laterals small; muscle-impressions as in *L. acutilineata.*

*Dimensions.*—Long. 31 mm.; alt. 29 mm.; diam. 16 mm.

Distinguishable from *L. acutilineata* by smaller size, close-set, concentric lines, and having the lunule wholly within the right valve.

Found in the Pliocene of Deadman Island; in the lower San Pedro series of Deadman Island and San Pedro; and rarely in the upper San Pedro series at Crawfish George's, San Pedro, Los Cerritos, Deadman Island, and Long Beach. Found also in the Pleistocene at the bath-house, Santa Barbara, and in the Pleistocene of Pacific Beach, San Diego.

*Living.*—Santa Cruz to San Diego (Cooper).

*Pleistocene.*—Santa Barbara; San Pedro (Cooper): San Pedro; Santa Barbara; San Diego (Arnold).

### 61. Lucina nuttalli *Conrad.*

*Lucina nuttalli* CON., Jour. Phil. Acad. Sci., Vol. VII, 1837, p. 255, fig. 2, Pl. XX. CPR., Brit. Assn. Rept., 1863, p. 642. GABB, Pal. Cal., Vol. II, p. 100, 1869. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 247. KEEP, West Coast Shells, p. 179, 1892. WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 190.

Shell small, orbicular, only slightly convex, thin; umbones depressed, small, central; surface ornamented by numerous sharp, regular, concentric lines and prominent radiating grooves, which are most prominent near the ends, the whole giving a rather cancellated appearance to the surface; lunule small, nearly all in left valve; hinge and interior as in *L. californica.*

*Dimensions.*—Long. 20 mm.; alt. 20 mm.; diam. 10 mm.

Distinguishable by small size, cancellated surface, and lunule in left valve. Specimens identified by Dr. Dall.

Common in the lower San Pedro series of Deadman Island and San Pedro; and in the upper San Pedro series of San Pedro, Los Cerritos, Crawfish George's, Deadman Island, and Long Beach. Found also in the Pliocene of Pacific Beach, and the Pleistocene of Twenty-sixth Street and Pacific Beach, San Diego.

*Living.*—Monterey to San Diego (Cooper).

*Pleistocene.*—Santa Barbara; San Pedro (Cooper): San Pedro; San Diego (Arnold).

*Pliocene.*—San Diego (Arnold).

### 62. **Lucina tenuisculpta** *Carpenter.*

*Lucina tenuisculpta* CPR., Brit. Assn. Rept., 1863, p. 642. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 247.

Shell small, orbicular, deeply convex, thin; umbones prominent, central; surface sculptured by numerous fine, concentric lines and radiating striæ; lunule prominent, the greater part being in the right valve; cardinal teeth small, laterals prominent; anterior muscle-impressions not as elongated as in *L. acutilineata* and others.

*Dimensions.*—Long. 9 mm.; alt. 8.8 mm.; diam. 6.4 mm.

Distinguishable by small size, sculptured surface, and great convexity. This species resembles *Diplodonta orbella* very closely in shape and size, but may be distinguished by the lack of prominent cardinal teeth, by its lateral teeth, and by the radiating striæ. Specimens identified by Dr. Dall.

Rare in the upper San Pedro series of San Pedro. Found also in the Pleistocene of Spanish Bight, San Diego.

*Living.*—Straits of Fuca to Catalina Island; Mazatlan (Cooper).

*Pleistocene.*—San Pedro; San Diego (Arnold).

*Pliocene.*—San Diego well (Dall).

## Family XXII. DIPLODONTIDÆ.

### Genus **Diplodonta** *Brown.*

#### Section *Diplodonta s. s.*

Shell rotund, equilateral, externally concentrically striated or smooth, with inconspicuous epidermis; two cardinal teeth in each valve, of which the right posterior and the left anterior are distally sulcate or bifid; no lateral teeth; the hinge-plate when developed is usually excavated distally; there is no circumscribed lunule or escutcheon; the adductor scars are subequal, continuous with the pallial line, and close to the hinge-plate; the margin is entire, the pallial line simple, and pallial area often radiately striate.

Type, *Diplodonta lupinus* Brocchi.

### 63. Diplodonta orbella *Gould.*

PLATE XVIII, FIGS. 8 AND 8*a*.

*Lucina orbella* GLD., Proc. Bost. Soc. Nat. Hist., Vol. IV, 1851, p. 90; Bost. Jour. Nat. Hist., Vol. VI, 1853, p. 395, Pl. XV, fig. 3; Cal. & Mex. Shells, p. 22, Pl. XV, fig. 3.

*Diplodonta orbella* GLD., GOULD & CARPENTER, Proc. Zool. Soc., 1856, pp. 202, 218. =*(Mysia) Sphairella tumida* CON. (*fide* CPR., Brit. Assn. Rept., 1863, p. 643). COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 238. KEEP, West Coast Shells, p. 179, 1892. WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 190. DALL, Trans. Wagner Inst. Sci., Vol. III, Part 5, 1900, p. 1189.

Shell small, subglobose, thin; beaks nearly median, not prominent; surface sculptured with fine incremental lines, which at some parts are more conspicuous than at others and render the surface somewhat irregular; no distinct lunule; ligament prominent; two cardinal teeth in right valve, of which the anterior is smallest, and the posterior bifid; and two in the left valve, of which the anterior is bifid, and the posterior very oblique; no lateral teeth; muscle-impressions large, faint.

*Dimensions.*—Long. 11.9 mm.; alt. 11.9 mm.; diam. 9 mm.

Resembles *Lucina tenuisculpta*, but may be distinguished by lack of radiating striæ, and by the prominent cardinal teeth and lack of lateral teeth. Specimens identified by Dr. Dall.

Rare in the lower San Pedro series at Deadman Island; and the upper San Pedro series of San Pedro and Crawfish George's. Found also in the Pleistocene of Twenty-sixth Street, San Diego. The specimen figured is from the lower San Pedro series of Deadman Island, and is now in the collection of Delos Arnold.

*Living.*—Straits of Fuca to San Diego (Cooper).

*Pleistocene.*—San Pedro to San Diego (Cooper): San Pedro; San Diego (Arnold).

*Pliocene.*—San Diego well (Dall).

### 64. Diplodonta serricata *Reeve.*

PLATE XVIII, FIGS. 5 AND 5*a*.

*Diplodonta serricata* RVE., CPR., Brit. Assn. Rept., 1856, p. 248.

Shell small, orbicular, only slightly convex, thin; umbones central, not prominent; surface sculptured with numerous fine, incremental lines, which are regular in prominence; lunule not distinct; hinge prominent; teeth and interior as in *D. orbella.*

*Dimensions.*—Long. 13.8 mm.; alt. 14 mm.; diam. 7 mm.

Distinguishable from *D. orbella* by its much less convexity and more regular concentric lines. Specimens identified by Dr. Dall.

Not uncommon in the upper San Pedro series of San Pedro. This species is very common in the Pleistocene deposits at Twenty-sixth Street, San Diego. The specimen figured is from this horizon, and is now in the collection of Delos Arnold.

*Living.*—Mazatlan (Carpenter).

*Pleistocene.*—San Pedro; San Diego (Arnold).

## Family XXIII. CRYPTODONTIDÆ.

### Genus **Thyasira** *Leach.*

Shell globular, posterior side furrowed or angulated; umbones much recurved; lunule short or indistinct; ligament usually and to a certain extent external, placed in a groove on the hinge-line, and outside the hinge-plate; teeth altogether wanting.

*Thyasira flexuosus* Mont. is a characteristic species.

### 65. **Thyasira bisecta** *Conrad.*

PLATE XV, FIG. 5.

*Venus bisecta* CON., Wilkes Expl. Exped., Vol. X, App. 1, p. 724, Pl. XVII, figs. 10, 10*a*, 1849.
*Thyatira? bisecta* CON., MEEK, Smithsonian Inst., Check-List Mioc. Fossils, 1864.
*Cyprina bisecta* CON., Jour. Conch., 1865, p. 153.
*Conchocele bisecta* CON. GABB., Pal. Cal., Vol. II, p. 99, 1869.
*Conchocele disjuncta* GABB, Pal. Cal., Vol. II, pp. 28, 29, Pl. VII, fig. 48, 1869. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 236.
*Cryptodon bisectus* CON., DALL, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 189; Vol. XVII, 1894, p. 713, Pl. XXVI, figs. 2-5.

Shell large, subquadrate, convex, of medium thickness, equivalve, inequilateral; beaks terminal, anterior; anterior end abruptly and angularly truncated; posterior dorsal margin arcuate, sloping down toward posterior extremity; surface marked only by lines of growth except near the posterior part, where the peculiar truncation takes place, the surface suddenly descending at right angles to the curve of the shell, for a short distance, and then resuming its former direction; ligament long and elliptical; large lunular area in front of the beaks.

*Dimensions.*—Long. 72 mm.; alt. 62 mm.; diam. 41 mm.

Specimens identified by Dr. Dall.

Gabb describes this shell as occurring in the Miocene of Deadman Island, while Cooper gives its occurrence as in the "Quaternary" of the same place. It is found most abundantly in a hard stratum near the base of the Deadman Island Pliocene deposits; a few shells, however, have been found in Pliocene strata above this layer; found also at Timm's Point in the Pliocene. The specimen figured is from the Pliocene of Deadman Island, and is now in the collection of Delos Arnold.

*Living.*—Puget Sound, sixty-nine fathoms (Dall).

*Pliocene.*—San Pedro (Arnold).

*Miocene.*—Astoria, Oregon (Conrad): Blakely, near Seattle, Washington (Arnold).

### 66. **Thyasira gouldi** *Philippi.*

*Cryptodon flexuosus* (not of MONTAGU) of CARPENTER, Brit. Assn. Rept., 1863, p. 643. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 237.

Shell small, globular, posterior side angulated or furrowed; umbones much recurved; surface sculptured with fine incremental lines; lunule indistinct, depressed in front of beaks; ligament external, placed in a groove on the hinge-line and outside the hinge-plate; teeth wanting.

*Dimensions.*—Long. 9.5 mm.; alt. 11 mm.; diam. 8 mm.

This species is distinguishable from *T. bisecta* by its much smaller size, more central umbones and less prominent lunule. Dr. Dall says that *T. gouldi* has been mistaken for *Cryptodon flexuosus* by West Coast collectors.

Rather common in the Pleistocene of Dead Man Island and Timm's Point. Not found above the horizon in the San Pedro deposits, so far as known.

*Living.*—Catalina Island (Cooper): Catalina Island, ten fathoms (Arnold).

*Pleistocene.*—Santa Barbara (Cooper).

*Pliocene.*—Santa Barbara; San Diego well (Cooper): San Pedro (Arnold).

## Superfamily LEPTONACEA.

## Family XXIV. LEPTONIDÆ.

### Genus Bornia *Philippi.*

Shell ovate or subtrigonal, subequilateral, with a more or less flattened disk; the periostracum usually brilliant; the surface smooth or divaricately more or less plicate; pallial line not sinuated, and the pallial area piquantly punctate or radially striate; hinge with one moderately long posterior, and two shorter anterior, laminæ in the left valve; in the right, one anterior and one longer, sometimes remote, posterior lamina; one or both of the anterior laminæ in either valve may have the aspect of cardinals; hinge-plate usually excavated.

Type, *Bornia corbuloides* (Phil.).

### 67. Bornia retifera *Dall.*

PLATE XVII, FIG. 12.

*Bornia retifera* DALL, Proc. U. S. Nat. Mus., Vol. XXI, 1899, p. 889, Pl. LXXXVII, fig. 2.

Shell thin, white, moderately convex, rounded, trigonal, nearly equilateral; beaks distinct, not high; surface polished, with faint incremental lines and minute, close punctations whose interspaces give the effect of a fine netting; hinge narrow, delicate; one tooth opposite beak, then a depression posterior to this, and then a second tooth completely filling the anterior end of the posterior ligamental groove; adductor scars rounded and high up.

*Dimensions*—Long. 7 mm.; alt. 5.5 mm.; diam. 3 mm.

Looks like a *Kellia laperousii*, but is distinguishable by the microscopic sculpture and hinge. Specimens identified by Dr. Dall.

One right valve from the lower San Pedro series of Deadman Island, which is figured herewith, and is now in the collection of Delos Arnold.

*Living.*—Station 2,900, thirteen fathoms, off Santa Barbara (Dall).

*Pleistocene.*—San Pedro (Arnold).

### Genus Kellia *Turton.*

#### Section *Kellia Turton s. s.*

Shell rounded and inflated, concentrically striated or smooth; with an obsolete external ligament and a large internal resilium without a lithodesma; two anterior and two posterior teeth in

each valve, of which the anterior ones are shorter and may be concrescent or free and pustular; interior of valves commonly shows radial striation; and valves frequently distorted.

Type, *Kellia suborbicularis* (Montagu).

### 68. Kellia laperousii *Deshayes.*

PLATE XVIII, FIGS. 7 AND 7*a*.

*Kellia laperousii* DESH., CARPENTER, Brit. Assn. Rept., 1863, p. 643. KEEP, West Coast Shells, p. 178, 1892. WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 191. DALL, Trans. Wagner Inst. Sci., Vol. III, Part 5, 1900, p. 1155.

Shell of medium size, suborbicular, convex, thin; umbones slightly anterior, not prominent; surface sculptured by fine incremental lines which are slightly variable as to prominence; no lunule; each valve with one very prominent cardinal tooth; right valve with two posterior laterals, left with one; hinge-area lacking between cardinal and lateral teeth; muscle-impressions not distinct.

*Dimensions.*—Long. 23 mm.; alt. 19 mm.; diam. 11 mm.

Distinguishable from *K. suborbicularis* by its larger size and less convexity. These two species may be recognized by their thin, suborbicular shells, and the lack of a hinge-area in the region of the umbones, the vacancy at first giving the impression that the hinge-area has been broken. Specimens identified by Dr. Dall.

Rare in lower San Pedro series of San Pedro and Deadman Island. One perfect valve from the Pliocene at Deadman Island. Found also in the Pleistocene of Spanish Bight, San Diego. The specimen figured is from the lower San Pedro series at Deadman Island, and is now in the collection of Delos Arnold.

*Living.*—Puget Sound to Monterey (Carpenter).

*Pleistocene.*—San Pedro (Arnold): San Diego (Arnold).

*Pliocene.*—San Pedro (Arnold).

### 69. Kellia suborbicularis *Montagu.*

PLATE XVIII, FIGS. 1 AND 1*a*.

*Kellia suborbicularis* MONT., Testacea Britannica, pp. 39, 564, Pl. XXVI, fig. 6, 1804. CARPENTER, Brit. Assn. Rept., 1863, p. 643. TRYON, Syst. Conch., Vol. III, p. 220, Pl. CXX, fig. 2, 1884. KEEP, West Coast Shells, p. 177, 1892. WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 191. DALL, Trans. Wagner Inst. Sci., Vol. III, Part 5, 1900, p. 1155.

Shell small, suborbicular, deeply convex, thin; beaks small, slightly anterior; surface ornamented with fine lines of growth which become somewhat irregularly constricted near margin, roughening the surface; no lunule; margins smooth; hinge and teeth as in *K laperousii.*

*Dimensions.*—Long. 8.4 mm.; alt. 7.4 mm.; diam. 5.8 mm.

Distinguishable from *K. laperousii* by smaller size and greater convexity. Specimens identified by Dr. Dall.

Rare in lower San Pedro series of San Pedro and Deadman Island. The

specimen figured is from the lower San Pedro series at Deadman Island, and is now in the collection of Delos Arnold.

*Living.*—Puget Sound to Lower California; England (Carpenter).

*Pleistocene.*—San Pedro (Arnold).

## Family XXV. KELLIELLIDÆ.

### Genus **Aligena** *H. C. Lea.*

Shell rounded, triangular, inflated; single small anterior tooth under the beaks, separated by a gap from the surface of attachment, under the posterior dorsal margin, of an elongate internal resilium carrying a lithodisma.

Type, *Aligena striata* (Lea).

### 70. **Aligena cerritensis,** sp. nov.

PLATE XIII, FIG. 3.

Shell small, rounded, triangular, inflated, thin; inequilateral, the umbo being nearly terminal posteriorly; anterior dorsal margin nearly straight; anterior extremity quite sharply rounded and produced furthest below middle; posterior extremity sloping off abruptly from umbo and rounded near base; ventral margin arcuate; surface with faint concentric sculpture; umbones small, pointed, anteriorly twisted, with a minute tooth below them on the cardinal margin; pallial line entire; muscle-scars subequal.

*Dimensions.*—Long. 8.5 mm.; alt. 8 mm.; diam. 5 mm.

This species resembles *Acila castrensis* in outline. Specimens identified by Dr. Dall, who pronounced it a new species.

Two specimens from the upper San Pedro series of Los Cerritos, one of which is the type, which is figured, and is now in the United States National Museum.

*Pleistocene.*—San Pedro (Arnold).

## Superfamily CARDIACEA.

## Family XXVI. CARDIIDÆ.

### Genus **Cardium** *(Linné) Lamarck.*

Shell variably sculptured, usually with predominantly radial ornamentation, usually closed or gaping but slightly, with no lunule or escutcheon; pallial line rather distant from the margin of the valves.

### Subgenus **Trachycardium** *Mörch.*

Shell rotund, closed, with the ribs imbricate or granulose; the channels also sometimes granulose; left cardinals anterior when interlocked.

Type, *Cardium isocardia* (Linné).

### 71. Cardium (Trachycardium) quadrigenarium *Conrad.*

*Cardium quadrigenarium* CON., Jour. Phil. Acad. Sci., Vol. VII, 1837, p. 230, Pl. XVII, fig. 5; = *luteolabrum* GLD. (*fide* CARPENTER, Brit. Assn. Rept., 1863, p. 642). COOPER, 7th Ann. Rept. Cal. St. Min., 1888, page 232. KEEP, West Coast Shells, p. 192, 1892. WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 190. DALL, Trans. Wagner Inst. Sci., Vol. III, Part. 5, 1900, p. 1091.

Shell large, oval, ventricose, thick; umbones central, prominent, turned only slightly anteriorly; surface sculptured with about forty prominent, subangular, smooth, radiating ridges, which are roughened by prominent pointed tubercles on their posterior angle; those ridges near the posterior margin are less prominent, but are nodose for nearly their whole length; teeth and interior as in *C. corbis;* margin sharply serrated.

*Dimensions.*—Long. 105 mm.; alt. 105 mm.; diam. 86 mm.

Distinguishable by large size and tuberculated ridges. Specimens identified by Dr. Dall.

Found in the upper San Pedro series of San Pedro, Los Cerritos and the Long Beach bluff. Found also in the Pleistocene of Twenty-sixth Street and Pacific Beach, San Diego.

*Living.*—Monterey to San Diego (Cooper).

*Pleistocene.*—San Pedro (Arnold): San Diego (Cooper; Arnold).

*Pliocene.*—Callegnas Ranch, Ventura County (Cooper).

### Subgenus **Ringicardium** *Fischer.*

Shell rotund, gaping, with flat ribs and channels, the posterior area with granulose channels; posterior margin sharply spinose, the spines crossing each other over the gap; left cardinals when interlocked posterior to the right ones.

Type, *Cardium ringens* (Gmel.).

### 72. Cardium (Ringicardium) procerum *Sowerby.*

PLATE XV, FIG. 6.

*Cardium procerum* SBY., CARPENTER, Brit. Assn. Rept., 1863, p. 620. DALL, Trans. Wagner Inst. Sci., Vol. III, Part 5, 1900, p. 1091.

*Cardium panamense*, not of SBY., of COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 232.

Shell of medium size, suboval, of medium thickness, ventricose, with a rather angular appearance at about one-fourth the length from the anterior margin; surface sculptured by about 22 subangular, smooth radiating ridges, with narrow, canel-like grooves between; each valve with three very prominent sharp teeth; margin sharply serrate.

*Dimensions*—Long. 1 mm.; alt. 23 mm.; diam. 19 mm.

Distinguishable by angular appearance near anterior side, and by the comparatively small number of smooth radiating ridges. Specimens identified by Dr. Dall.

Rather common in the upper San Pedro series of San Pedro, Long Beach and Los Cerritos; one specimen from the lower San Pedro series of Deadman Island. The specimen figured is from the upper San Pedro series at San Pedro, and is now in the

collection of Delos Arnold. Found abundantly in the Pleistocene of Twenty-sixth Street and Spanish Bight, San Diego.

*Living.*—Gulf of California to Panama (Dall).

*Pleistocene.*—San Pedro (Cooper; Arnold): San Diego (Cooper; Dall; Arnold).

Subgenus **Cerastoderma** *Mörch.*

Shell rotund or obovate, closed; with strong ribs obsoletely granulose or intricate or smooth; no posterior or anterior area; channels single; hinge normal.

Type, *Cardium edule* (Linné).

### 73. Cardium (Cerastoderma) corbis *Martyn.*

*Pectunculis corbis* MART., Univ. Conch., Pl. XXVIII, fig. 2, p. 1784.
*Cardium corbis* MART., CARPENTER, Brit. Assn. Rept., 1863, p. 642, =*C. californicum* CON. =*C. nuttalli* CON. (*fide* GABB, Pal. Cal., Vol. II. p. 98, 1869). COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 232. KEEP, West Coast Shells, p. 180, fig. 153, 1892. DALL, Trans. Wagner Inst. Sci., Vol. III, Part 5, 1900, p. 1093.

Shell large, subtrigonal, ventricose, thick; umbones prominent, anterior to center; surface ornamented with about thirty-seven prominent, regular, squarish, close-set, radiating ridges, which are made more or less rugose by incremental ridges on their surface; near the posterior margin these ridges become more rounded and less prominent; between the ridges are equal, deep, canal-like grooves; margin crenulated; ligament short, external, prominent; each valve with one prominent cardinal tooth, and two laterals, one anterior and the other posterior; muscle impressions prominent, subequal.

*Dimensions.*—Long. 71 mm.; alt. 71 mm.; diam. 57 mm.

Distinguishable by the regular, only slightly rugose ridges. Specimens identified by Dr. Dall.

Found in the lower San Pedro series of Deadman Island and San Pedro; and in the upper San Pedro series of Deadman Island, San Pedro, Los Cerritos and Crawfish George's. Found also in the Pleistocene of the bath-house, Santa Barbara.

*Living.*—Kodiak to Santa Barbara; Kamtschatka (Cooper).

*Pleistocene.*—San Francisco; Monterey; San Pedro (Cooper): San Pedro; Santa Barbara (Arnold).

Subgenus **Lævicardium** *Swainson.*

Shell thin, oval, closed; middle of the valves smooth or feebly radially sculptured; ends with a smooth area; hinge normal, but with the anterior laterals springing from the umbonal cavity; periostracum smooth.

Type, *Cardium norvegicum* (Spengler).

### 74. Cardium (Lævicardium) elatum *Sowerby.*

PLATE XX.

*Cardium elatum* SBY., Conch Ill., Vol. I, 1838. REEVE, Conch. Icon., Pl. VIII, fig. 41. VALENCIENNES, Voy. Venus, Pl. XVII, fig. 1, 1846.

*Liocardium elatum* SBY., CARPENTER, Brit. Assn. Rept., 1863, p. 642. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 246. KEEP, West Coast Shells, p. 181, 1892. WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 190.

*Lævicardium elatum* SBY., GABB, Pal. Cal., Vol. II, p. 99, 1869. DALL, Trans. Wagner Inst. Sci., Vol. III, Part 5, 1900, p. 1111.

Shell large, oval, oblique, elongated, equivalve, somewhat inequilateral; surface sculptured by numerous faint, squarish, radiating ribs, and fine, wavy incremental lines; inner surface of margin corrugated; hinge strong, with one prominent cardinal and one prominent anterior lateral tooth in each valve; muscle-impressions distinct.

*Dimensions.*—Long. 144 mm.; alt. 167 mm.; diam. 136 mm.

This is the largest of the *Cardiidæ*, and is easily recognizable by its immense size and nearly smooth surface. A fine pair of this species, described above, and figured, was found in the upper San Pedro series at the north end of the San Pedro bluff. Another specimen was obtained by Dr. A. A. Wright and Mrs. Oldroyd in the upper San Pedro deposits of Los Cerritos. This species is one of the typical southern forms found in the upper San Pedro series.

*Living.*—San Pedro to Mazatlan (Cooper).

*Pleistocene.*—San Pedro (Cooper; Arnold): San Diego (Gabb; Dall).

### 75. Cardium (Lævicardium) substriatum *Conrad.*

*Cardium substriatum* CON., Jour. Phil. Acad. Sci., Vol. VII, 1837, p. 228, Pl. XVII, fig. 2.

*Liocardium substriatum* CON, = *cruentatum* GOULD, (*fide* CARPENTER, Brit. Assn. Rept., 1863, p. 642.) COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 246. KEEP, West Coast Shells, p. 181, fig. 154, 1892. WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 190.

*Lævicardium substriatum* CON., GABB, Pal. Cal., Vol. II, p. 99, 1869. DALL, Trans. Wagner Inst. Sci., Vol. III, Part 5, 1900, page 1111.

Shell small, obliquely ovate, ventricose, thin; surface smooth, except for minute incremental lines and nearly obsolete radiating striæ; one small sharp cardinal tooth in each valve; two narrow elongated lateral teeth in each valve, the posterior one in the left valve not prominent; interior of margin finely crenulated.

*Dimensions.*—Long. 17 mm.; alt. 18 mm.; diam. 13 mm.

Distinguishable by its small size and smooth surface. Specimens identified by Dr. Dall.

Rare in the lower San Pedro series of Deadman Island and San Pedro, and in the upper San Pedro series of Deadman Island, San Pedro, Crawfish George's, and Los Cerritos. Found also in the Pleistocene at Twenty-sixth Street, San Diego.

*Living.*—Monterey to South America (Cooper).

*Pleistocene.*—Santa Barbara; San Pedro; San Diego (Cooper): San Pedro (Arnold): San Diego (Arnold).

### Genus **Protocardia** *Beyrich.*

Shell globose, with a posterior area sharply distinguished by sculpture from the rest of the surface; closed; hinge normal; no lunule or escutcheon.

Type, *Cardium hillanum* (Sowerby).

#### 76. **Protocardia centifilosa** *Carpenter.*

*Cardium* var. *centifilosum* CPR., Brit. Assn. Rept. 1863, p. 642.
*Cardium centifilosum* CPR., GABB, Pal. Cal., Vol. II, p. 99, 1869. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 232. WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 189.
*Protocardia centifilosa* CPR., DALL, Trans. Wagner Inst. Sci., Vol. III, Part 5, 1900, p. 1113.

Shell small, suboval, ventricose, thin; umbones central, prominent, only very slightly bent; surface sculptured by numerous fine, close-set, rounded, radiating ridges, which are made slightly rugose by numerous fine, incremental lines on their surface; thin, sharp teeth in each valve; pallial sinus shallow, wide; margin beautifully and sharply serrate.

*Dimensions.*—Long. 23 mm.; alt. 22.5 mm.; diam. 15 mm..

Distinguishable by the nearly circular outline and numerous fine, radiating ridges. Specimens identified by Dr. Dall.

Not uncommon in the Pliocene of Deadman Island and Timm's Point; rare in the lower San Pedro series of Deadman Island. Found also in the Pleistocene at bath-house and the Pliocene of Packard's Hill, Santa Barbara.

*Living.*—Monterey to Catalina Island (Cooper).

*Pleistocene.*—San Pedro (Cooper; Arnold): Santa Barbara (Arnold).

*Pliocene.*—San Pedro (Arnold): San Diego well (Dall): Santa Barbara (Arnold).

*Pliocene.*—Sunol, Alameda County (Cooper).

## Superfamily VENERACEA.

## Family XXVII. VENERIDÆ.

### *Subfamily VENERINÆ.*

### Genus **Tivela** *Link.*

Shell triangular, subequilateral, cuneiform; three to five cardinal teeth in one valve, four to six in the other; anterior lateral tooth narrow, elongated, compressed; pallial impression with a short oblique or sometimes horizontal sinus.

*Cytherea* is a characteristic species.

### 77. Tivela crassatelloides *Conrad.*

*Cytherea* (*Trigonella*) *crassatelloides* CON., Jour. Phil. Acad. Sci., Vol. VII, 1837, p. 253, Pl. XIX, fig. 17. HINDS, Voyage Sulpher, p. 65, Pl. XXI, fig. 1, 1844.

*Donax stultorum* MARVE, LINN., Lyst. Conch., pp. 37, 40, Pl. IX, fig. 7, 1823. GRAY, Index. Test. Suppl., Pl. II (*Donax*), fig. 2, 1828.

*Cytherea crassatelloides* CON., HANLEY, Descr. Cat. Rec. Bivalve Shells, p. 106, 1843. SOWERBY, Thes. Conch., Vol. II, p. 612, Pl. CXXVII, figs. 1–3. REEVE, Icon. Conch., Vol. XIV, Pl. I, fig. 3, 1864.

*Cytherea stultorum* GRAY, HANLEY, Descriptive Cat. Rec. Bivalve Shells, p. 106, 1843.

*Trigonella crassatelloides* CON., Jour. Phil. Acad. Sci., Vol. I, 1849, p. 213.

*Trigonia crassatelloides* CON., DESHAYES, Cat. Conch. Coll. B. M., Part 1, p. 46, 1853.

*Trigonia stultorum* GRAY, DESHAYES, Cat. Conch. Coll. B. M., Part 1, p. 46, 1853.

*Pachydesma crassatelloides* CON., Proc. Phil. Acad. Sci., 1854, p. 121. CARPENTER, Brit. Assn. Rept. 1863, p. 640; =*Cytherea solidissima* PHIL., GABB, Pal. Cal. Vol. II, p. 96, 1869. COOPER, 7th. Ann. Rept. Cal. St. Min., 1888, p. 256. KEEP, West Coast Shells, p. 189, fig. 162, 1892.

*Tivela crassatelloides* CON., WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 187.

*Cytherea* (*Tivela*) *crassatelloides* CON., STEARNS, Proc. U. S. Nat. Mus., Vol. XXI, 1898, pp. 371–378, Pl. XXIII–XXV. STEARNS, Nautilus, Vol. XIII, 1899, p. 73.

Shell large, subequilateral, trigonal, depressed, thick; umbones subcentral, small; anterior extremity shorter and more obtusely rounded than posterior; anterior dorsal margin nearly straight, slopes down obliquely from umbo; posterior dorsal margin slightly concave in front of umbo, slope less than anterior; posterior extremity narrower than anterior; three prominent, thick, cardinal teeth in each valve, anterior lateral tooth elongated; pallial sinus short, angular.

*Dimensions.*—Long. 80 mm.; alt. 55 mm.; diam. 30 mm.

The Pleistocene specimens have a tendency toward more central umbones than do the living forms. This species is distinguishable from the Mactras by its very thick shell and heavy cardinal teeth. Specimens identified by Dr. Dall.

Common in the upper San Pedro series of San Pedro, Los Cerritos, Long Beach, Crawfish George's and Deadman Island; rare in the lower San Pedro series of Deadman Island. Found also in the Pleistocene of Twenty-sixth Street and Spanish Bight, San Diego.

*Living.*—Santa Cruz to San Diego (Cooper).

*Pleistocene.*—Santa Barbara to San Diego (Cooper): San Pedro; San Diego; (Arnold).

## Genus **Callista** *Poli.*

Shell oval, transverse, inequilateral; pallial sinus suboval, profound.

*Cytherea erycina* Linn. is a characteristic species.

### 78. Callista newcombiana *Gabb.*

*Lioconcha newcombiana* GABB, Proc. Cal. Acad. Sci., 1865, p. 189; Pal. Cal., Vol. II, p. 96, 1869.

*Callista newcombiana* GABB, COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 231. WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 187, Pl. XXIII, fig. 4.

Shell thin, trigonally ventricose, polished, marked by minute concentric striæ; beaks large, subcentral; anterior end prominent, narrowly rounded; posterior end a little the widest; base arcuate;

lunule not excavated, but bounded by an impressed line; hinge not strong; two small cardinal teeth; ligamental area excavated, internal.

*Dimensions.*—Long. 38 mm.; alt. 30 mm.; diam. 10 mm.; length of lunule 12 mm.

This species is distinguishable from *C. subdiaphana* Carpenter by its prominent impressed lunule-bounding line, rounded pallial sinus, and by its coloration in the living specimens.

Rare in upper San Pedro series at Deadman Island. Abundant at Twenty-sixth Street, San Diego.

*Living.*—Monterey to Catalina Island (Cooper): San Pedro (Williamson).

*Pleistocene.*—San Pedro (Arnold): San Diego (Cooper; Arnold).

*Pliocene.*—San Diego well (Cooper).

### 79. **Callista subdiaphana** *Carpenter.*

PLATE XIII, FIG. 4.

*Clementia subdiaphana* CPR., Brit. Assn. Rept. 1863, p. 640; Proc. Phil. Acad. Sci., 1865, p. 56. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 235. DALL, Proc. U. S. Nat. Mus., Vol. XIV, 1891, p. 185, Pl. VII, figs. 5 and 6.

Shell of medium size, oval, transverse, inequilateral, ventricose, rather thin; beaks small, incurved; anterior extremity quite sharply angulated about middle of shell; posterior extremity much longer and wider than anterior and very evenly rounded, projecting furthest a little below the middle; ventral margin evenly arcuate; surface sculptured by numerous fine, regular, concentric, incremental lines; neither lunule nor escutcheon, but a faint lunular circumscribing line in front of umbo; three prominent, sharp, cardinal teeth in each valve, the anterior one being narrower and longer than the other two; external ligamental groove long, narrow; pallial sinus cuneiform, rather deep.

*Dimensions.*—Long. 43.5 mm.; alt. 34 mm.; diam. 26 mm.; umbo to anterior extremity 10 mm.; to posterior extremity 33.5 mm.

This species is very close to Conrad's *Dione angustiformis* from the Astoria Miocene, the external characteristics of both being almost identical. Specimens identified by Dr. Dall.

Rather common in the Pliocene of Deadman Island and Timm's Point. Cooper's "Quarternary" at San Pedro includes the Pliocene, and his specimens from San Pedro were probably from the Pliocene. The writer has never found *Callista subdiaphana* in the Pleistocene of San Pedro or vicinity. The specimen figured is from the Pliocene of Deadman Island, and is now in the collection of Delos Arnold.

*Living.*—South Alaska Coast to San Francisco (Dall).

*Pleistocene.*—San Pedro to San Diego (Cooper).

*Pliocene.*—San Diego well (Cooper): San Pedro (Arnold).

### 80. **Callista subdiaphana** *Carpenter*, **pedroana**, var. nov.

PLATE XIII, FIG. 2.

Shell of medium size, subelliptical, transverse, inequilateral, ventricose, rather thin; beaks small, incurved; anterior extremity evenly rounded, short; posterior extremity faintly biangular,

caused by a slight, very oblique truncation across the middle of the extremity; posterior portion of the ventral line nearly straight; interior the same as in *C. subdiaphana.*

*Dimensions.*—Long. 32.5 mm.; alt. 24 mm.; diam. 15 mm.

This variety is very distinct from the typical *C. diaphana*, being much narrower, less ventricose and smaller; and having a shorter, more rounded anterior extremity, a biangular posterior extremity, and a nearly straight ventral margin.

This variety has been found only in the lower San Pedro series of Deadman Island.

*Pleistocene.*—San Pedro (Arnold).

### Subgenus **Amiantis** *Carpenter.*

Fulcra very thick and surface very concentrically rugose.

Type, *Cytherea callosa* Conrad.

### 81. Callista (Amiantis) callosa *Conrad.*

*Cytherea callosa* CON., Jour. Phil. Acad. Sci., Vol. VII, 1837, p. 252.
*Venus callosa* CON., SOWERBY, Thes. Conch., Vol, II, p. 712, Pl. CXIV, figs. 44, 45.
*Dosinia callosa* CON., CARPENTER, Proc. Zool. Soc., 1856, p. 216.
*Amiantis callosa* CON., CARPENTER, Brit. Assn. Rept., 1863, p. 640. GABB., Pal. Cal., Vol. II, p. 96, 1869. TRYON, Syst. Conch., Vol. III, p. 178, 1884. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 266. KEEP, West Coast Shells, p. 187, fig. 160, 1892. COOPER, Bull. No. 7, 1894, Cal. St. Min. Bureau, p. 24.
*Meretrix callosa* CON., FISCHER, Conchologie, p. 1079, 1887.
*Callista (Amiantis) callosa* CON.; =*Dione nobilis* RVE. (*fide* DALL, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 187).

Shell large, suboval, inequilateral, equivalve, heavy; umbones anterior to center, prominent, recurved; anterior dorsal margin slightly concave; anterior extremity quite sharply rounded near upper margin; ventral margin evenly arcuate; posterior dorsal margin slightly arcuate; posterior extremity faintly biangular; surface sculptured by numerous prominent, flat-topped, concentric ridges, between which are interspaces equal in width to the ridges; lunule distinct, concentrically striated; hinge heavy; two prominent, strong cardinal teeth; pallial sinus wide, deep and rather pointed.

*Dimensions.*—Long. 66 mm.; alt. 55 mm.; diam. 34 mm.; umbo to anterior extremity 20 mm.; to posterior extremity 46 mm.

Cooper (Seventh Ann. Rept. Cal. St. Min., p. 266) says that this species is like *Tapes montana*, described by Conrad from the "Miocene of San Buenaventura." Specimens identified by Dr. Dall.

Common in the upper San Pedro series of Los Cerritos, but exceedingly rare in the same horizon of San Pedro. This species is very abundant in the Pleistocene at Spanish Bight, San Diego.

*Living.*—Santa Barbara to Lower California (Carpenter).

*Pleistocene.*—San Pedro (Arnold): San Diego (Arnold).

Subfamily *Dosininæ.*

Genus **Dosinia** *Scopoli.*

Shell orbicular, compressed, concentrically striated, pale, ligament sunk; lunule deep; hinge like *Cytherea;* margin even; pallial sinus deep, angular, ascending.

*Dosinia discus* Reeve is a characteristic species.

[S. D.] **Dosinia ponderosa** *Gray.*

*Artemis ponderosa* GRAY, Analyst, Vol. VIII, 1838, p. 309.

*Dosinia ponderosa* GRAY, H. & A. ADAMS, Gen. Rec. Moll., Vol. II, p. 432; =*Cytherea gigantea* SBY. (*fide* GABB, Pal. Cal. Vol. II, p. 97, 1869). COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 239.

Shell large, thick, equivalve, subcircular in outline, convex; surface sculptured by many obsolete, concentric lamellæ, and fine, incremental lines; lunule deeply impressed, small, finely sculptured; beaks small, not elevated; hinge very wide and heavy, with three heavy, cardinal teeth, the posterior one in the right valve being bifid; ligament long, narrow, sunken.

*Dimensions.*—Long. 119 mm.; alt. 105 mm.; diam. 55 mm.; lunule 15 mm.

Common in the upper San Pedro series (Pleistocene) of Twenty-sixth Street, San Diego.

*Living*—West Mexican coast to Panama (Carpenter).

*Pleistocene.*—San Diego (Hemphill; Arnold).

*Pliocene.*—Kirker's Pass, Contra Costa County; San Fernando (Cooper): Stanford University, Santa Clara County (Arnold).

Genus **Venus** *Linné.*

Shell thick, ovate, smooth, sulcated, or cancellated; margins minutely crenulated; cardinal teeth three in each valve; pallial sinus small, angular; ligament prominent; lunule distinct.

*Venus verrucosa* Linné is a characteristic species.

[S. B.] **Venus perlaminosa** *Conrad.*

*Mercenaria perlaminosa* CON., Proc. Phil. Acad. Sci., 1855, p. 267. GABB, Pal. Cal.. Vol. II, pp. 22, 55, 94; Pl. V, fig. 38; Pl. XV, fig. 14; 1869. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 250.

*Venus kennerleyi* RVE., Icon. Conch. (*Venus*), Pl. XII, fig. 41 (*fide* GABB).

"Shell large, thick, rounded, subquadrate, very inequilateral; beaks anterior; anterior end excavated under the beaks, rounded below; base broadly rounded; posterior end convexly truncated; cardinal margin slightly convex. Surface closely marked by numerous prominent, recurved, lamelliform concentric ribs. Lunule marked by an impressed line, Hinge robust. Pallial line strong, sinus small, oblique, acute at base; muscular scars nearly equal in size; margin minutely crenulated; the purple color between the pallial line and the base is very persistent."—[GABB.]

Found in the Pliocene at Packard's Hill, and in the Pleistocene at the bath-house, Santa Barbara.

Subgenus **Chione** *Megerle.*

Shell oval, triangular or subcordiform; margins finely crenulated; hinge narrow, solid, with three teeth in the right valve and two in the left, the anterior tooth longest; ligament narrow; pallial sinus shallow.

*Venus gnidia* Brod. is a characteristic species.

### 82. Venus (Chione) fluctifraga *Sowerby.*

PLATE XIV, FIG. 2.

*Venus fluctifraga* SBY., Thes. Conch., 1842-1859.

*Chione fluctifraga* SBY., +*C. callosa* SBY.; = *Venus cortezi* SLOAT; = *V. gibbosula* (DESH.) RVE. (*fide* CARPENTER, Brit. Assn. Rept., 1863, pp. 641, 666). COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 234. KEEP, West Coast Shells, p. 187, 1892. WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 188.

Shell of medium size and thickness, suboval; surface roughened by radiating rows of squarish blocks, this condition being caused by wide concentric ridges being cut by radiating sulcations; spaces between the concentric ridges ornamented by fine, even, incremental lines; lunule of same sculpture as shell, scarcely differentiated; two prominent teeth and a rudimentary anterior one in the right valve; pallial sinus quite deep; muscle-impressions elongate-oval.

*Dimensions.*—Long. 25 mm.; alt. 21 mm.; diam. 15 mm.

Distinguishable from others of this genus found in these beds by being more swollen, oval rather than cordiform in shape, thinner shelled, by the "blocked" surface, and by the lunule being scarcely differentiated from the rest of the shell. Specimen identified by Dr. Dall.

Rare in upper San Pedro series of San Pedro; one specimen, a right valve, which is figured, and is now in the collection of Delos Arnold. Common in the Pleistocene at Twenty-sixth Street, San Diego.

*Living.*—San Pedro to San Diego; Gulf of California (Cooper).

*Pleistocene.*—Santa Barbara; San Diego (Cooper): San Pedro; San Diego (Arnold).

### 83. Venus (Chione) gnidia *Broderip & Sowerby.*

PLATE XIV, FIG. 7.

*Venus gnidia* SBY., Gen. Rec. & Fos. Shells (*Veneridæ*), fig. 7, 1824.

*Venus gnidia* BROD. & SBY., Zool. Jour., Vol. IV, 1829, p. 364; Zool. Beechey's Voyage, p. 151, Pl. XLI, fig. 3, 1839. REEVE, Syst. Conch., Vol. I, fig. 5, 1841. CARPENTER, Brit. Assn. Rept., 1856, p. 175; 1863, p. 561.

*Chione gnidia* BROD. & SBY., TRYON, Syst. Conch., Vol. III, p. 176, Pl. CXIII, fig. 14, 1884.

Shell large, thick, subcordiform; surface ornamented by several prominent, palmate, concentric frills and numerous squarish, radiating ribs between which are canal-like sulcations of about equal width with the ribs; the ribs are sharper in outline near the beak and multiply in number both by division and intercalation as the margin is approached; near the periphery, and also on the anterior portion of the shell, the ridges become wider and less prominent, and in some cases almost obsolete; the concentric frills become widely separated in the adult shell; lunule prominent, shows fine laminæ

of growth which are most prominent when projections of the frills; hinge narrow, solid; three cardinal teeth in right valve, two in left; ligament narrow; pallial sinus much shorter than lunule; muscle-impressions distinct.

*Dimensions.*—Long. 98 mm.; alt. 83 mm.; diam. 62 mm.; lunule 18 mm.

This is the largest of the genus found in these deposits and is easily distinguishable by its size, prominent concentric frills and numerous radiating ribs. The specimen whose dimensions are given above had twenty-four concentric frills and about ninety radiating ribs. Specimens identified by Dr. Dall.

Rare in the upper San Pedro series of San Pedro, whence the specimen figured came. This specimen is now in the collection of Delos Arnold.

*Living.*—Gulf of California to Panama (Carpenter).

*Pleistocene.*—San Pedro (Arnold).

### 84. Venus (Chione) neglecta *Sowerby.*

PLATE XIV, FIG. 3.

*Venus neglecta* SBY., Thes. Conch., 1842–1849. CARPENTER, Brit. Assn. Rept., 1856, p. 306.

Shell of medium size and thickness, suboval; surface ornamented with quite numerous, about equidistant, undulating, concentric, low frills, and numerous unequal, rounded, radiating ridges, which are most prominent on the middle of the shell; lunule prominent, ornamented with minute concentric and radiating sculpture; hinge and pallial sinus are as in *C. succinta.*

*Dimensions.*—Long. 29.5 mm.; alt. 24 mm.; diam. 13 mm.; lunule 6 mm.

This species is close to *C. succincta,* but may be differentiated by its more oval outline, thinner shell, relatively less diameter, and less prominent but more numerous concentric frills. Specimen identified as "probably *C. neglecta*" by Dr. Dall.

Rare in upper San Pedro series of San Pedro and Los Cerritos. The specimen figured is from the upper San Pedro series at San Pedro, and is now in the collection of Delos Arnold.

*Living.*—Gulf of California and Central America (Carpenter).

*Pleistocene.*—San Pedro (Arnold).

### 85. Venus (Chione) simillima *Sowerby.*

*Venus simillima* SBY., Thes. Conch., p. 708, Pl. CLIII, figs. 17, 18, 1842–1859.
*Chione simillima* SBY., CARPENTER, Brit. Assn. Rept., 1863, p. 641. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 234. KEEP, West Coast Shells, p. 186, 1892. WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 188.

Shell of medium size, thick, subcordiform; surface ornamented by numerous slightly crenulated, reflexed, concentric frills, which grow closer and closer together as the periphery is approached, and by about twenty bifurcated, radiating ridges, which are largest in the middle of the shell, becoming obsolete anteriorly and posteriorly, and increasing in number, but fading out as the periphery is approached; lunule prominent. ornamented with incremental laminæ; hinge narrow; only two prominent cardinal teeth on each valve; pallial sinus very shallow; margin crenulated.

*Dimensions.*—Long. 40 mm.; alt. 35 mm.; diam. 25 mm.; lunule 9 mm.

Distinguishable from others of this genus occurring in these deposits by the even, close, lattice-like sculpture. Specimens identified by Dr. Dall.

Common in upper San Pedro series at San Pedro, Los Cerritos, Crawfish George's, and Deadman Island; rare in the lower San Pedro series at Deadman Island. Found also in the Pleistocene at Twenty-sixth Street, San Diego.

*Living.*—Monterey to Lower California (Carpenter).

*Pleistocene.*—Santa Barbara to San Diego (Cooper): San Pedro; San Diego (Arnold).

### 86. Venus (Chione) succincta *Valenciennes.*

PLATE XIV, FIG. 1.

*Venus succincta* VAL., HUMB. & BONPL., Obs. sur Zool., p. 219, Pl. LXVIII, fig. 1, 1833.

*Chione succincta* VAL. = *C. californiensis* BROD. = *C. nuttalli* CON. (*fide* CARPENTER, Brit. Assn. Rept., 1863, p. 641.)

*Chione succincta* VAL. = *Venus californica* CON. = *V. nuttalli* CON. = *V. lamellifera* CON. (Wilkes' Exped. and Jour. Conch., 1865; not *V. lamellifera* CON., Jour. Phil. Acad., Vol. VII, which = *Tapes staminea* var. *ruderata*) = *V. brevilineata* CON. = *Chione brevilineata* CON. = *V. securis* SHUM. (*fide* GABB, Pal. Cal., Vol. II, p. 94, 1869). COOPER, 7th Ann. Rept Cal. St. Min., 1888, p. 234. KEEP, West Coast Shells, p. 187, fig. 159, 1892. WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 188.

Shell of medium size, thick, subcordiform; surface ornamented by several about equidistant, slightly reflexed, low, concentric frills and numerous rounded, radiating ridges, most prominent on the middle of the shell, which increase by intercalation and become flattened and less prominent as the periphery is approached; lunule prominent, ornamented by both incremental laminæ and rounded, radiating ridges; hinge narrow; two prominent cardinal teeth in each valve; pallial sinus very shallow; margin crenulated.

*Dimensions.*—Long. 55 mm.; alt. 50 mm.; diam. 32 mm.; lunule 13.5 mm.

The specimen whose measurements are given was the largest of the specimens examined. Distinguishable by the equidistant concentric frills, low, rounded, radiating lines, and radiating lines on the lunule.

Rather common in upper San Pedro series of San Pedro, Los Cerritos, Crawfish George's and Deadman Island. Found also in the Pleistocene of Barlow's ranch, Ventura, and Twenty-sixth Street, San Diego. The specimen figured is from the upper San Pedro series at San Pedro, and is now in the collection of Delos Arnold.

*Living.*—Santa Barbara to San Diego; Mexico; South America (Cooper).

*Pleistocene.*—Santa Barbara to San Diego (Cooper): San Pedro (Arnold).

*Pliocene.*—Seven Mile Beach, San Mateo County; San Fernando (Cooper).

*Miocene.*—Oregon; Martinez; San Pablo; Griswold's, San Benito County; Foxin's, Santa Barbara County; Santa Monica (Cooper).

## Superfamily TAPETINÆ.

### Genus Tapes *Megerle.*

Shell oblong, umbones anterior; margins smooth; teeth three in each valve, more or less bifid; pallial sinus deep, rounded.

*Tapes litterata* Linné is a characteristic species.

### 87. Tapes laciniata *Carpenter.*

PLATE XIV, FIG. 5.

*Tapes laciniata* CPR., Brit. Assn. Rept., 1863, p. 641; Jour. de Conch., Vol. XII, 1865, p. 136. KEEP, West Coast Shells, p. 186, 1892. WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 188.

Shell large, oval, swollen, thick, but brittle; surface net-like, caused by prominent, thick rounded, concentric frills, and numerous rounded, radiating ridges; margin smooth; hinge and interior parts as in *T. staminea.*

*Dimensions.*—Long. 80 mm.; alt. 68 mm.; diam. 56 mm.

Resembles *T. staminea* in outline, but is much larger, heavier, and more brittle, and has a much more decided cancellate sculpture.

Rare in upper San Pedro series at San Pedro, but rather common at Los Cerritos in the same horizon. The specimen figured is from the upper San Pedro series at Los Cerritos, and is now in the collection of Delos Arnold.

*Living.*—Monterey to San Diego (Carpenter).

*Pleistocene.*—San Pedro (Arnold).

### 88. Tapes staminea *Conrad*

PLATE XIV, FIG. 4.

*Venus staminea* CON., Jour. Phil. Acad. Sci., Vol. VII, 1837, p. 250, Pl. XIX, fig. 15,

*Tapes staminea* CON., CARPENTER, Brit. Assn. Rept., 1863, p. 641; = *V. lamellifera* CON., (Jour. Phil. Acad., Vol. VII, 1837; not of Wilkes' Exped.); = *T. diversum* CON.; = *T. lineatum* CON.; = *Venus rigida* GLD. (*fide* GABB, Pal. Cal., Vol. II, p. 97, 1869). COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 266. KEEP, West Coast Shells, p. 185, fig. 158, 1892. WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 188.

Shell of medium size and thickness, suboval, convex; surface sculptured with numerous, crowded, rounded, radiating ridges, and concentric lines, which are most prominent on anterior end; no lunule; margin sometimes crenulated; hinge narrow; ligament narrow, long; three teeth in each valve; posterior two in right valve and middle one in left valve bifid; pallial sinus long, rounded; muscle-impressions not sunken.

*Dimensions.*—Long. 50 mm.; alt. 42.5 mm.; diam. 30 mm.

This is a variable species, the shape of the shell and the sculpture varying in different individuals. The form above described is the most common in the San Pedro beds. Specimens identified by Dr. Dall.

Rare in the lower San Pedro series at Deadman Island and San Pedro; common in the upper San Pedro series at Deadman Island, San Pedro, Los Cerritos, Crawfish George's and Long Beach. The specimen figured is from the upper San Pedro series of San Pedro and is now in the collection of Delos Arnold. Found in the Pliocene at Pacific Beach and Russ School; and in the Pleistocene at Twenty-sixth Street and Spanish Bight, San Diego.

*Living.*—Straits of Fuca to Lower California (Cooper).

*Pleistocene.*—Santa Barbara to San Diego (Cooper): San Pedro; San Diego (Arnold).

*Pliocene.*—Santa Rosa; Twelve Mile House, San Mateo County; Kirker's Pass, Contra Costa County; Monterey; San Fernando (Cooper); San Diego (Arnold).

*Miocene.*—West of San Jose; Foxin's, Santa Barbara County (Cooper).

### 89. Tapes tenerrima *Carpenter.*

PLATE XIV, FIG. 6.

*Tapes tenerrima* CPR., Proc. Zool. Soc., 1856, p. 200; (jun.) = *Venus rigida* GLD., pars. (*fide* CARPENTER, Brit. Assn. Rept., 1863, p. 641.) GABB, Pal. Cal., Vol. II, p. 97, 1869. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 267. KEEP, West Coast Shells, p. 157, fig, 136, 1892. WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 188.

Shell large and thin, oval, convex; surface sculptured by numerous low, sharp, concentric frills, and numerous fine, rounded, crowded, radiating lines, these latter lines being almost obsolete in some specimens; margin smooth, hinge long and narrow; three teeth in each valve, the anterior two in the right valve and the middle one in the left valve prominently bifid; pallial sinus very deep and rounded; no lunule.

*Dimensions.*—Long. 86 mm.; alt. 63.5 mm.; diam. 34 mm.

This is the largest and finest *Tapes* found in these deposits, and is easily distinguishable by its large, thin, shallow shell and regular, oval outline. Specimens identified by Dr. Dall.

Rather rare in the upper San Pedro series of San Pedro, Los Cerritos, Crawfish George's and Deadman Island. The specimen figured is from the upper San Pedro series at San Pedro, and is now in the collection of Delos Arnold. Found also in the Pleistocene at Barlow's ranch, Ventura, and at Spanish Bight, San Diego.

*Living.*—Straits of Fuca to San Diego (Cooper).

*Pleistocene.*—Santa Barbara (Cooper): San Pedro; San Diego; Ventura (Arnold).

*Pliocene.*—Santa Barbara (Cooper).

## Genus **Saxidomus** *Conrad.*

Shell transversely oval, inequilateral, solid, ventricose; without lunule; umbones tumid; teeth three or four, inequal, narrow, the central bifid; ligament very thick, elongated; muscular impressions oval or rounded, nearly equal; pallial sinus large, elongated, horizontal.

Type, *Saxidomus nuttallii* (Con.).

### 90. Saxidomus aratus *Gould.*

*Saxidomus aratus* GLD., Otia Conch., p. 168, 1862. CARPENTER, Brit. Assn. Rept., 1863, p. 641. KEEP, West Coast Shells, p. 183, 1892. WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 188.

*Tapes gracilis* GLD., Pac. R. R. Rept., Vol. V., p. 333, Pl. XIX, fig. 20, 1853.

*Saxidomus gracilis*, GLD., = *Venus maxima* PHIL. (*fide* GABB, Pal. Cal., Vol. II, 1869, p. 98). COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 263.

Shell large, transversely elliptical, equivalve, inequilateral, convex, thick; umbones turned, anterior to middle; anterior end evenly rounded; posterior end much more produced, having a slight tendency toward biangulation; surface sculptured with strong, elevated concentric lines, which in the adult often have the prominence of concentric lamina; ligamental area external, wide, long, strong; cardinal teeth four, anterior one long and narrow; pallial sinus long, rather narrow, rounded extremity near middle of shell and impressed against the posterior adductor scar.

*Dimensions.*—Long. 89 mm.; alt. 62 mm.; diam. 44 mm.; umbo to anterior extremity 30 mm.; to posterior extremity 59 mm.

Specimens identified by Dr. Dall.

Rare in the lower San Pedro series of Deadman Island; common in the upper San Pedro series at Deadman Island, Crawfish George's, Los Cerritos and San Pedro. Found also in the Pleistocene at Barlow's ranch, Ventura, and at Twenty-sixth Street, San Diego.

*Living.*—Baulines Bay to San Diego (Cooper).

*Pleistocene.*—Santa Barbara to San Diego (Cooper): San Pedro; Blakeley, near Seattle, Washington (Arnold): San Diego; Ventura (Arnold).

*Pliocene.*—Kirker's Pass, Contra Costa County; Twelve Mile House, San Mateo County; Santa Barbara, San Fernando (Cooper).

*Miocene.*—Martinez; Walnut Creek, Contra Costa County; Santa Cruz; Santa Inez, Santa Barbara County; Santa Monica (Cooper).

### *Subfamily GEMMINÆ.*

### Genus **Psephis** *Carpenter.*

Shell thin, rounded or quadrangular, somewhat inflated; pallial sinus small; three elongated, thin, cardinal teeth in each valve.

*Psephis lordi* (Baird) is a characteristic species.

#### 91. **Psephis salmonea** *Carpenter.*

*Psephis salmonea* CPR., Brit. Assn. Rept., 1863, p. 641. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 261.

Shell very small, ovate trigonal, inequilateral; posterior end evenly rounded; posterior dorsal margin rounded; in other ways resembles *P. tantilla.*

*Dimensions.*—Long. 5 mm.; alt. 4 mm.; diam. 2.5 mm.

Distinguishable from *P. tantilla* by smaller size and less trigonal outline. Specimens examined showed no coloration.

Rare in the lower San Pedro series at Deadman Island and San Pedro. Found also in the Pliocene at Packard's Hill, and in the Pleistocene at the bath-house, Santa Barbara.

*Living.*—Catalina Island (Cooper; Arnold): 10 fathoms (Arnold, 1901).

*Pleistocene.*—Santa Barbara (Cooper): San Pedro; Santa Barbara (Arnold).

*Pliocene.*—Santa Barbara (Arnold).

### 92. Psephis tantilla *Gould.*

PLATE XIII, FIG. 5.

*Venus tantillus* GLD., Bost. Jour. Nat. Hist., Vol. VI, 1853, p. 906, Pl. XV, fig. 10.
*Trigonia tantilla* GLD., CARPENTER, Proc. Zool. Soc., 1856, p. 201.
*Psephis tantilla* GLD., CARPENTER, Brit. Assn. Rept., 1863, p. 640; = *Venus rysonia* GABB (*fide* GABB. Pal. Cal., Vol. II, p. 96, 1869). COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 261. KEEP, West Coast Shells, p. 186, 1892. WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 188.

Shell small, ovate-trigonal, inequilateral; beaks acute, slightly anterior to center; surface smooth or faintly waved with distant, concentric furrows; the dorsal margins are nearly straight, and meet at the apex in a right angle, but the posterior side is a fourth longer than the anterior; the anterior basal angle is well rounded, while the posterior is acute; basal margin gently curved; hinge area short, wide; three prominent, elongated cardinal teeth in each valve.

*Dimensions.*—Long. 10 mm.; alt. 8 mm.; diam. 4.9 mm.

Somewhat resembles a very small *Tivela crassatelloides.* Some show original purple spot on posterior end. Specimens identified by Dr. Dall.

Rather common in the lower San Pedro series at Deadman Island and San Pedro; rarer in the upper San Pedro series at Deadman Island, Los Cerritos, and San Pedro. The specimen figured is from the lower San Pedro series at Deadman Island and is now in the collection of Delos Arnold.

*Living.*—Straits of Fuca to Catalina Island (Cooper).

*Pleistocene.*—Santa Barbara (Cooper): San Pedro (Arnold).

## Family XXVIII. COOPERELLIDÆ.

### Genus **Cooperella** *Carpenter.*

Shell small, thin, smooth, or concentrically striate or undulate, equivalve, nearly equilateral, with entire margins; ligament long; resilium short; hinge plate narrow, carrying two right and three left subumbonal, divaricating, short cardinal teeth; laterals none; pallial line narrow, with an ample sinus.

Type, *Œdalia subdiaphana* (Carpenter).

### 93. Cooperella subdiaphana *Carpenter.*

PLATE XIII, FIG. 1.

*Œdalia subdiaphana* CPR., Brit. Assn. Rept., 1863, p. 639; Jour. de Conch., Vol. XII, 1865, p. 134.
*Œdalina subdiaphana* CPR., Proc. Cal. Acad. Sci., Vol. III, 1866, p, 208.
*Cooperella subdiaphana* CPR., DALL, Trans. Wagner Inst. Sci., Vol. III, Part 5, 1900, p. 1062.

Shell small, subquadrangular, subequilateral, convex, very thin and fragile; posterior extremity evenly rounded; anterior extremity rounded near base; surface smooth except for incremental lines; beaks slightly raised, sharp, prominent; two narrow, tall, sharp, bifid teeth in left valve, three in right; pallial sinus very large.

*Dimensions.*—Long. 12 mm.; alt. 9 mm.; diam. 6 mm.

Externally this species much resembles a *Kellia*, but may be distinguished by the pallial sinus and hinge teeth. Specimens identified by Dr. Dall.

Two left valves from lower San Pedro series of Deadman Island, one of which is figured, and is now in the collection of Delos Arnold. Rather common in the Pleistocene at Spanish Bight, San Diego.

*Living.*—Vancouver Island to Todos Santos Bay (Dall).

*Pleistocene.*—San Pedro (Dall; Arnold): San Diego (Arnold).

## Family XXIX. PETRICOLIDÆ.

### Genus **Petricola** *Lamarck.*

Shell oval or elongated, thin, tumid, anterior side short; hinge with generally three teeth in each valve, the external often obsolete; pallial sinus deep.

Type, *Venus lapicida* (Chemn.).

### Section *Petricola Lamarck s. s.*

Shell ovate, with a short or moderately wide pallial sinus, the radial sculpture more or less divaricate or zigzag.

Type, *Petricola lapicida* (Gmel.).

#### 94. **Petricola carditoides** *Conrad.*

*Saxicava carditoides* CON., Jour. Acad. Nat. Sci. Phil., Vol. VII, 1837, p. 255, Pl. XX, fig. 8.
*Petricola carditoides* CON., Jour. Acad. Nat. Sci. Phil., 1849, p. 213. CARPENTER, Proc. Zool. Soc., 1856, p. 214; =*P. californica* CON. =*P. cylindracea* DESH. =*P. arcuata* DESH. =*P. gibba* MIDD. (*fide* CARPENTER, Brit. Assn. Rept., 1863, p. 641). COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 258. KEEP, West Coast Shells, p. 183, 1892. WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 189. DALL, Trans. Wagner Inst. Sci., Vol. III, Part 4, 1898, p. 835; Part 5, 1900, p. 1059.

Shell of medium size and variable outline, generally oblong-oval, convex, thick; surface ornamented with fine, concentric, incremental lines, which sometimes form irregular ridges, and by fine, wavy, radiating lines; hinge-area prominent; three cardinal teeth in each valve, the anterior one smallest; margin smooth.

*Dimensions.*—Long. 28 mm.; alt. 25 mm.; diam. 16 mm.

A variable form which is recognized, however, by its sculpture, prominent teeth and thick shell. Often found in holes in the pebbles and boulders comprising the conglomerate in this formation. Specimens identified by Dr. Dall.

Not uncommon in the lower San Pedro series at Deadman Island; and in the upper San Pedro series at Deadman Island, Los Cerritos, Crawfish George's, and San Pedro. Found also in the Pleistocene at Spanish Bight, San Diego.

*Living.*—Sitka to San Diego (Cooper).

*Pleistocene.*—San Pedro to San Diego (Cooper): San Pedro; San Diego (Arnold).

Section *Rupellaria Fleurian.*

Shell inflated and rounded in front, attenuated and more compressed behind; sculpture chiefly radial; stronger anteriorly.

Type, *Petricola lithophaga* (Retzius).

### 95. Petricola (Rupellaria) lamellifera *Conrad.*

*Venus lamellifera* CON., Jour. Phil. Acad. Nat. Sci., Vol. VII, 1837, p. 257, Pl. XIX, fig. 19.
*Venerupis cordieri* var. *B*, DESH., B. M. Catal. Ven., p. 191, No. 1.
*Petricola cordieri* DESH., Rev. Zool. Soc. Cur., 1839, p. 358; Mag. Zool., Pl. XVIII.
*Rupellaria lamellifera* CON., CARPENTER, Proc. Zool. Soc., 1856, p. 214. CARPENTER, Brit. Assn. Rept., 1863, p. 641. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 262. KEEP, West Coast Shells, p. 183, fig. 156, 1892. WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 184.

Shell of medium size, convex, equivalve, inequilateral, thick; beaks anterior to middle, marginal, not much elevated, turned slightly forward; anterior extremity evenly rounded; posterior extremity widely truncated; surface sculptured by ten or twelve lamelliform, concentric, slightly reflected ribs, and rather faint radiating sulcations; lunule indistinct, sculptured; ligament rather short; hinge strong, with two bifid and one single tooth in each valve; pallial sinus deep, narrow, pointed; muscle-impressions distinct, oval.

*Dimensions.*—Long. 26 mm.; alt. 21.5 mm.; diam. 16 mm.

This species resembles *Petricola carditoides*, but is distinguishable by the prominent concentric lamellar frills. Like *P. carditoides* this shell bores in the rocks; and all of the specimens obtained were broken from the shale pebbles in the upper San Pedro gravels of Deadman Island.

*Living.*—Farallon Islands to San Diego (Cooper).

*Pleistocene.*—Santa Barbara (Cooper): San Pedro (Arnold).

Section *Petricolaria Stoliczka.*

Shell elongated, pholadiform, thin; hinge-teeth protracted, slender; pallial sinus deep.

Type, *Petricola pholadiformis* (Lane).

### 96. Petricola (Petricolaria) denticulata *Sowerby.*

*Petricola denticulata* SBY., Thes. Conchyliorum (?).
*Petricola pedroana* CON., Pac. R. R. Rept., Vol. V, p. 324, Pl. III, fig. 24, 1856. GABB, Pal. Cal., Vol. II, p. 119, 1869.
*Petricola denticulata* SBY., CARPENTER, Brit. Assn. Rept., 1856, pp. 244, 297.
*Cypricardia pedroana* CON., COOPER, Bull. No. 4, Cal. St. Min. Bureau, 1894, p. 25.

Shell small, elongate-oval, convex, thin; surface sculptured by fine, concentric, incremental lines, and numerous, undulating, radiating ridges, which are most prominent on the anterior portion of the shell; anterior end short and rounded; teeth small; pallial sinus deep.

*Dimensions.*—Long. 20 mm.; alt. 12 mm.; diam. 10 mm.

Distinguishable from *P. carditoides* by its smaller size, narrower form, thinner shell, and coarser sculpture. Specimens of this same species in the State Museum collection at the University of California, Berkeley, are labeled *P. cognata* Adams. Specimens identified by Dr. Dall.

Rare in the lower San Pedro series at Deadman Island, and the upper San Pedro series at Los Cerritos and San Pedro.

*Living.*—Mazatlan to Peru (Carpenter).

*Pleistocene.*—San Pedro (Arnold; Blake.)

*Pliocene* (?).—Los Angeles City (Williamson).

### 97. Petricola (Petricolaria) cognata *C. B. Adams.*

*Petricola cognata* C. B. ADS., Cat. Panama Shells; Ann. N. Y. Lyc. Nat. Hist., Vol. V, 1852, p. 510. CPR., Brit. Assn. Rept., 1856, p. 363; Proc. Zool. Soc., 1863, p. 367.

Shell of medium size, much elongated, transverse, convex, thin, equivalve; beaks small, near anterior extremity, turned forward, slightly elevated; anterior extremity short, evenly, pointedly rounded; posterior extremity long, evenly, pointedly rounded; surface of shell, anterior to a line running obliquely backwards from the beaks, sculptured by ten or eleven prominent, narrow, squamosely spined, radiating ridges; surface posterior to this line ornamented by finer radiating lines; rather prominent incremental lines over the whole surface; hinge of left valve consists of a curved, saddle-shaped process of two teeth, one of which is bifid; hinge of right valve smaller and straighter with less prominent division of teeth.

*Dimensions.*—Long. 36 mm.; alt. 10.5 mm.; diam. 10 mm.; beaks to anterior extremity 6 mm.; to posterior extremity 30 mm.

The line of demarkation between the fine and prominent radiating sculpture in this species is not marked as in the *Pholadidæ*. Distinguishable from *P. denticulata* by more prominent sculpture anteriorly, longer shell, more prominent hinge-teeth and more anterior beaks. *P. cognata* is close to the Atlantic *P. pholadiformis*. Some authorities, notably Carpenter, unite the two forms.

Rare in the upper San Pedro series at the lumber yard at San Pedro and at Deadman Island.

*Living.*—San Pedro to Panama (Dall, mss.).

*Pleistocene.*—San Pedro (Arnold).

## Superfamily TELLINACEA.

## Family XXX. TELLINIDÆ.

### Genus **Tellina** *Linné.*

### Subgenus **Mœrella** *Fischer.*

Shell small, compressed, hardly folded, acute behind, rounded in front, with feeble, concentric sculpture; left laterals obsolete; no interior radii; the sinus long, coalescent with the pallial line below.

Type, *Tellina donacina* (Linné).

### 98. Tellina (Mœrella) salmonea *Carpenter.*

PLATE XIII, FIG. 7.

*Mœra salmonea* CPR., Brit. Assn. Rept., 1863, p. 639; Ann. & Mag. Nat. Hist., 3rd Ser., Vol. IV, 1864, p. 423. KEEP, West Coast Shells, p. 196, 1892.

Shell small, suboval, convex, equivalve, inequilateral, thin; umbones anterior to center, small, sharp; anterior extremity short, rounded; posterior dorsal margin straight; posterior extremity acutely rounded; ventral margin evenly arcuate; surface glossy, ornamented with fine, concentric, incremental lines, and obsolete radiating scratches; cardinal tooth small, bifid; no lateral teeth; pallial sinus long, broad; one faint, internal, submarginal, posterior, radiating ridge.

*Dimensions.*—Long. 11 mm.; alt. 8 mm.; diam 4.2 mm.; umbo to anterior extremity 3 mm.; to posterior extremity 8 mm.

Resembles *Donax*, but is much thinner, more evenly rounded anteriorly, has no lateral teeth, and is not crenulated on the interior of the margin. Specimen identified by Dr. Dall.

Not uncommon in the lower San Pedro series at Deadman Island, whence the specimen figured came. This specimen is now in the collection of Delos Arnold.

*Living.*—Vancouver to Monterey (Carpenter).

*Pleistocene.*—San Pedro (Arnold).

### Subgenus **Angulus** *Megerle.*

Shells elongated, generally small, compressed, with the posterior end angularly pointed and not twisted; the surface smooth or with fine concentric sculpture; nymphs short and prominent, the ligament short; hinge with a single adjacent lateral well developed in the right valve anteriorly; internally a thickened ray passes from the umbo just behind the anterior adductor scars, and one or two narrower similar rays in front of the posterior adductors; sinus largely coalescent with the pallial line below.

Type, *Tellina lanceolata* Linné.

### 99. Tellina (Angulus) buttoni *Dall.*

PLATE XVI, FIGS. 1 AND 2.

*Tellina (Oudardia) buttoni* DALL, Trans. Wagner Inst. Sci., Vol. III, Part 5, 1900, p. 1036, Pl. XLVII, fig. 18.

*Angulus modestus* of California collectors (not of CARPENTER).

*Tellina (Angulus)* var. *obtusus* CPR. (not *Tellina obtusa* SOWERBY.)

*? Tellina pedroana* CON., Pac. R. R. Rept., Vol. V, p. 323, Pl. III, fig. 17, 1855.

*? Macoma pedroana* CON., GABB, Pal. Cal., Vol. II, pp. 94, 124, 1869. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 248.

Shell small, oblong, subtriangular, compressed, thin; umbones slightly posterior to center; anterior dorsal margin evenly arcuate; anterior extremity quite acutely rounded, produced furthest near base; ventral line subrectilinear; posterior extremity cuneiform, abruptly truncated at end near base; surface sculptured by fine, concentric, incremental lines; one prominent cardinal tooth in each valve; one sharp, anterior lateral tooth in right valve; pallial sinus large, does not quite reach to anterior muscle-impression; anterior, radiating callus passes from umbo just posterior to the anterior muscle-impression.

*Dimensions.*—Long. 18 mm.; alt. 10.5 mm.; diam. 4 mm.; umbo to anterior extremity 11 mm.; to posterior extremity 7 mm.

A note accompanying one of these specimens says, "*Tellina striata* Hanley. This specimen was identified by Dr. Dall." Upon further examination Dr. Dall pronounced them to be *Angulus buttoni.*

Found in lower San Pedro series of Deadman Island and San Pedro bluffs; and in the upper San Pedro series of Deadman Island, San Pedro, Crawfish George's, and Los Cerritos. Found also in the Pleistocene at Barlow's ranch, Ventura. The specimen figured is from the upper San Pedro series at San Pedro, and is now in the collection of Delos Arnold.

*Living.*—West Coast.

*Pleistocene.*—San Pedro; Ventura (Arnold).

### 100. Tellina (Angulus) bodegensis *Hinds.*

PLATE XV, FIG. 8.

*Tellina bodegensis* HDS., Voy. Sulphur, p. 67, Pl. XXI, fig. 2, 1844. CARPENTER, Brit. Assn. Rept., 1863, p. 639; =*T. emacerata* CON. (*fide* GABB, Pal. Cal., Vol. II, p. 92, 1869). COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 267. KEEP, West Coast Shells, p. 197, fig. 169, 1892. WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 185. DALL, Trans. Wagner Inst. Sci., Vol. III, Part 5, 1900, p. 1029.

Shell of medium size, elongated, narrow-ovate, rather thick; umbones posterior to center and pointing posteriorly; anterior portion of shell evenly rounded, the dorsal and ventral lines being nearly parallel; posterior dorsal margin depressed back of umbo, running off quite obliquely to a line which truncates the posterior end near the base; basal posterior angle nearly a right angle; basal line nearly straight; a prominent bifid cardinal tooth on each valve; pallial sinus long and narrow; generally thickened anteriorly.

*Dimensions.*—Long. 48 mm.; alt. 25 mm.; diam. 12 mm.; umbo to anterior extremity 27 mm.; to posterior extremity 21 mm.

Specimen identified by Dr. Dall.

Common in the upper San Pedro series at San Pedro, Los Cerritos, Crawfish George's, Deadman Island, and Long Beach; rarer in the lower San Pedro series at Deadman Island and San Pedro. Found also in the Pleistocene at Spanish Bight, San Diego. The specimen figured is from the upper San Pedro series at San Pedro, and is now in the collection of Delos Arnold.

*Living.*—Straits of Fuca to San Diego; Japan (Cooper).

*Pleistocene.*—San Pedro to San Diego (Cooper): San Pedro; San Diego (Arnold).

*Miocene.*—Oregon; Walnut Creek, Contra Costa County (Cooper).

### 101. Tellina (Angulus) idæ *Dall.*

PLATE XV, FIG. 7.

*Tellina idæ* DALL, Proc. U. S. Nat. Mus., Vol. XIV, 1891, p. 183, Pl. VI., fig. 3; Pl. VII, figs. 1, 4. WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 185. COOPER, Bull. No. 4, Cal. St. Min. Bureau, Part 3, 1894, p. 32.

*Tellinella,* COOPER, No. 63, Geol. Cat., 1867.

Shell of medium size, ovate-triangular, moderately elongate, compressed, thin; beaks subcentral, small, pointed, prominent; anterior extremity evenly rounded; posterior dorsal slope steeper, rectilinear, obliquely truncate at its termination; ventral margin moderately incurved at flexure, which is narrow, but well marked, and extends out into a prominent beak at the extremity of the shell; a prominent, narrow, submarginal, flexural ridge extends from beak to posterior extremity; surface sculptured with numerous, regular, sharp, elevated, concentric, incremental lines; hinge area broad and strong; one prominent cardinal tooth in each valve, which is bifid in right valve; one anterior lateral in right valve; ligamental area prominent, long; pallial sinus very large, extending nearly to anterior adductor scar.

*Dimensions.*—Long. 62 mm.; alt. 37 mm.; diam. 10 mm.

Distinguishable from *T. bodegensis* by larger, broader shell, more central, less curved beaks, much more prominent flexural ridge, posterior beak and incurved base line, much stronger, broader hinge, and much larger pallial sinus. Distinguishable from *T. rubescens* by more extended, beaked posterior extremity, flexural ridge, straight beaks, and much stronger hinge, especially in the ligamental area. Specimens identified by Dr. Dall.

One valve found in the upper San Pedro series at Los Cerritos, which is figured herewith, is now in the collection of Delos Arnold.

*Living.*—Catalina Island, 16 to 38 fathoms, young (Dall): San Pedro Bay; Long Beach (Shephard).

*Pleistocene.*—San Pedro (Arnold).

### 102. Tellina (Angulus) rubescens *Hanley.*

PLATE XV, FIG. 9.

*Tellina rubescens* HANL., CARPENTER, Brit. Assn. Rept., 1856, p. 302.

Shell of medium size, ovate-triangular, compressed, thin; beaks posterior, small, sharp, turned toward the rear; anterior dorsal margin evenly but slightly arcuate to near extremity, where it turns off quite abruptly, giving an evenly rounded end, which is most produced below the middle; posterior dorsal slope steeper, rectilinear; posterior extremity truncated, with a rounded right angle at base; basal margin nearly rectilinear from posterior angle to within one-third length of shell from anterior end; a prominent angular ridge extends from beak to posterior basal angle; surface sculptured by regular alternating concentric bands and distinct sulcations; sculpture less regular posterior to angular ridge; hinge-area small; right valve with two cardinal teeth, posterior one bifid; one posterior lateral tooth at lower end of ligamental area in right valve; pallial sinus large, arcuate upwards near middle and extending nearly to anterior adductor scar.

*Dimensions.*—Long. 43 mm.; alt. 26 mm.; diam. 10 mm.; beak to anterior extremity 23 mm.; to posterior extremity 20 mm.

Distinguishable from *T. bodegensis* by much broader shell, less oblique truncations, greater convexity, more regular and coarser sculpture, stronger hinge, posterior lateral tooth, and much larger pallial sinus, which extends almost to anterior adductor. Distinguishable from *T. idæ* by less produced and unflexed posterior portion, basal posterior angle, and rectilinear ventral margin, weaker hinge, and posteriorly bent beaks. This species seems to lie between *T. idæ* and *T. bodegensis* in many respects, having the large sinus of the one and the general, though much broader, outline of the other. Specimen identified by Dr. Dall.

Rare in upper San Pedro series of San Pedro; one perfect right valve, which is figured, is now in the collection of Delos Arnold.

*Living.*—Panama; Central America (Carpenter).

*Pleistocene.*—San Pedro (Arnold).

### Genus **Metis** *H. & A. Adams.*

Shell slightly inequivalve, suborbicular, compressed; valve sillonated; posterior flexuosity submedian; no lateral teeth.

*Tellina meyeri* Phil. is a characteristic species.

### 103. **Metis alta** *Conrad.*

*Tellina alta* CON., Jour. Phil. Acad. Nat. Sci., Vol. VII, 1837, p. 258; (not *T. alta* CON., Foss. Tert. Form., Vol. I, No. 4, p. 41, 1833. HANLEY, Thes. Conch., Vol. I, p. 332, Pl. LXII, fig. 200, 1847.

*Lutricola alta* CON., CARPENTER, Brit. Assn. Rept., 1863, p. 639; =*Arcopagia medialis* CON. (*fide* GABB, Pal. Cal., Vol. II, p. 92, 1869). COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 247. KEEP, West Coast Shells, p. 197, 1892. WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 186.

*Metis alta* CON., =*Scrobicularia biangulata* CPR. (*fide* DALL, Trans. Wagner Inst. Sci., Vol. III, Part 5, 1900, p. 1044).

Shell large, suboval, approaching to subcircular, ventricose, of medium thickness; beaks central; anterior extremity obtusely rounded; posterior side of the deeper valve biangulated; the opposite valve with an angular groove; surface sculptured by numerous prominent lines of growth and by numerous minute, radiating lines; cartilage-pit more vertical than oblique; muscle-impressions large.

*Dimensions.*—Long. 75 mm.; alt. 65 mm.; diam. 40 mm.

Resembles a large, rounded, ventricose *Macoma*. Specimens identified by Dr. Dall.

Common in upper San Pedro series of San Pedro, and exceedingly so in the Pleistocene of Los Cerritos, where they occur in beautifully preserved pairs. A few specimens found in the upper San Pedro series at Deadman Island and Crawfish George's; and in the lower San Pedro series at Deadman Island. Found in the Pliocene at Pacific Beach, and in the Pleistocene at Spanish Bight, San Diego.

*Living.*—Santa Barbara to San Diego (Cooper).

*Pleistocene.*—San Pedro (Cooper; Arnold): San Diego (Arnold).

*Pliocene.*—Santa Barbara (Cooper): San Fernando (Cooper; Arnold): San Diego (Arnold).

*Miocene.*—Monterey; El Toro Ranch, Monterey County (Cooper).

### Genus **Macoma** *Leach.*

Shell without lateral teeth, usually subtrigonal and with a marked posterior flexure; the surface feebly sculptured concentrically, or smooth; the siphons naked.

Type, *M. tenera* Leach.

## Subgenus **Macoma** *s. s.*

Shell subtrigonal, the periostracum conspicuous; usually colorless, or, if colored, without color pattern; flexure well marked; the pallial sinus coalescent with the pallial line below, and often discrepant in the two valves; inhabiting the cooler seas, and especially boreal waters.

### 104. Macoma calcarea *Gmelin.*

PLATE XVI, FIG. 2.

*Tellina calcarea, teste ovata*, etc., CHEM., Conch. Cab., Vol. VI, p. 140, Pl. XIII, fig. 136, 1782.
*Tellina calcarea*, GMELIN, Syst. Nat., Ed. VI, p. 3236, No. 38, 1792.
*Macoma calcarea* CHEM. = *Sanguinolaria californica* CON. = *Tellina pedroana* CON. = *Tellina tenera* LEACH (*fide* GABB, Pal. Cal., Vol. II, p. 124, 1869). COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 248.
*Macoma calcarea* GMELIN. = *Tellina lata* GMELIN. = *Tellina subulosa* SPENGLER. = *Macoma tenera* LEACH = *Tellina proxima* (BROWN) SBY. = *Tellina sordida* COUTHOUY. = *Sanguinolaria sordida* GLD. (*fide* DALL, Trans. Wagner Inst. Sci., Vol. III, Part 5, 1900).

Shell of medium size, suboval, slightly convex, inequilateral, thin; anterior end shorter than posterior, with fold running from apex to lower anterior extremity, which is biangular; anterior dorsal margin straight; anterior end evenly rounded; beaks anterior to middle, small, inconspicuous; surface sculptured by fine incremental lines; two cardinal teeth on left valve, anterior one bifid; pallial sinus large.

*Dimensions.*—Long. 18.2 mm.; beak to anterior extremity 8.2 mm.; to posterior extremity 10 mm.; alt. 13.5 mm.; diam. 5.2 mm.

This species is distinguishable from *M. yoldiformis* by its more prominent fold and much broader form; distinguished from others of this genus found in these deposits by having the anterior (folded and angular) end shorter than the posterior end. Specimens identified by Dr. Dall. Specimens of this species are labeled "*M. expansa*" in the State Museum Collection, at the University of California, at Berkeley.

Several specimens from the lower San Pedro series and Pliocene of Deadman Island. The specimen figured is from the lower San Pedro series at Deadman Island, and is now in the collection of Delos Arnold.

*Living.*—Arctic and boreal seas, south on Atlantic Coast to Long Island Sound, on Pacific Coast to Oregon and Northern Japan (Dall).

*Pleistocene.*—Scandinavia; Scotland; Greenland; Siberia; Alaska (Dall): San Pedro (Arnold).

*Pliocene.*—San Pedro (Arnold).

### 105. Macoma indentata *Carpenter.*

PLATE XVI, FIG. 1.

*Macoma indentata* CPR., Brit. Assn. Rept., 1863, p. 639. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 248. KEEP, West Coast Shells, p. 195, 1892. WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 185. DALL, Trans. Wagner Inst. Sci., Vol. III, Part 5, 1900, p. 1052.

Shell of medium size, rather narrow, suboval, compressed, thin; umbones slightly posterior to center; anterior end long and evenly rounded; posterior dorsal line straight; ventral line near

posterior end indented, the posterior extremity being much projected and sharply rounded; fold very prominent; ligamental area short, scooped out.

*Dimensions.*—Long. 50 mm.; alt. 32 mm.; diam. 14 mm.; umbo to anterior exremity 28 mm.; to posterior extremity 22 mm.

Resembles *M. nasuta* and *M. kelseyi*, but is distinguishable by its smaller shell, posterior umbones, indentation in ventral margin, more prominent fold and more prominently projected posterior extremity. Specimen identified by Dr. Dall.

Rare in the upper San Pedro series at Los Cerritos and San Pedro. Found in the Pleistocene at Spanish Bight, San Diego. The specimen figured is from the upper San Pedro series at Los Cerritos, and is now in the collection of Delos Arnold.

*Living.*—Monterey to San Diego (Cooper).

*Pleistocene.*—San Pedro (Arnold): San Diego (Cooper; Arnold).

*Miocene.*—El Toro Ranch, Monterey County; Griswold's, San Benito County (Cooper).

### 106. Macoma inquinata *Deshayes.*

PLATE XVI, FIG. 4.

*Tellina inquinata* DESH., Proc. Zool. Soc., 1854, p. 357.
*Macoma inquinata* DESH., CARPENTER, Brit. Assn. Rept., 1863, p. 689. GABB, Pal. Cal., Vol. II, p. 93, 1869. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 248. KEEP, West Coast Shells, p. 195, 1892. DALL, Trans. Wagner Inst. Sci., Vol. III, Part 5, 1900, p. 1053.

Shell of medium size, suboval, convex, thin, equivalve; umbones subcentral; anterior end dilated, rather prominently so in front of umbo of right valve; posterior end evenly arcuate from umbo and acutely rounded at posterior end about half way between dorsal and ventral margins; ligament of medium length, not prominent; two small cardinal teeth in each valve; pallial sinus does not reach anterior muscle-impression in the left valve.

*Dimensions.*—Long. 35 mm.; alt. 27 mm.; diam. 15 mm.; umbo to anterior extremity 16 mm.; to posterior extremity 19 mm.

Distinguishable by medium size, short, equally convex valves, very faint or obsolete fold; evenly, acutely rounded, rather than truncated, posterior extremity, and disconnection of pallial sinus and anterior muscle-impression. Specimen identified by Dr. Dall.

Not uncommon in the Pliocene at Deadman Island, the lower San Pedro series at Deadman Island, and the upper San Pedro series at Deadman Island, San Pedro, Los Cerritos, and Crawfish George's. Found also in the Pleistocene at Twenty-sixth Street, San Diego.

The specimen figured is from the upper San Pedro series at San Pedro, and is now in the collection of Delos Arnold.

*Living.*—Alaska to San Diego (Cooper).

*Pleistocene.*—Monterey to San Diego (Cooper): San Pedro; San Diego (Arnold).

*Pliocene.*—Twelve Mile House; San Fernando (Cooper).

### 107. Macoma nasuta *Conrad.*

PLATE XVI, FIG. 3.

*Tellina nasuta* CON., Jour. Phil. Acad. Sci., Vol. VII, 1837, p. 258.

*Macoma nasuta* CON. = *M. tersa* GLD., (*fide* CARPENTER, Brit. Assn. Rept., 1863, p. 639). GABB, Pal. Cal., Vol. II, p. 93, 1869. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 248. KEEP, West Coast Shells, p. 194, fig. 165, 1892. WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 185. DALL, Trans. Wagner Inst. Sci., Vol. III, Part 5, 1900, p. 1053.

Shell of medium size, ovate, compressed, thin; anterior side dilated; posterior side cuneiform, extremity truncated much above the line of the base; posterior dorsal margin straight to angle where it joins line of truncation; fold carinated on the right valve; umbones slightly anterior to center, slightly prominent; two prominent narrow cardinal teeth in each valve; no laterals; ligament external, long, straight, narrow; pallial sinus large, expanding interiorly, that of the left valve joining anterior muscle-impression at its lower posterior angle.

*Dimensions.*—Long. 76 mm.; alt. 54 mm.; diam. 23 mm.; umbo to anterior end 31 mm.; to posterior end 45 mm.

Distinguishable from *M. secta* by smaller size, less convex valves, less altitude, longer, straight posterior margin, and longer, less prominent ligamental callus; from *M. inquinata* by larger, longer shell, less convex valves, less relative altitude, straight dorsal margin with truncation posteriorly, and by less central umbones; from *M. yoldiformis* by more cuneiform posterior extremity, long, straight posterior dorsal margin, and by having the beaks anterior to center rather than posterior; from *M. identata* by beaks being more anterior, being broader, and by lacking the prominent folds, indentation of ventral margin, and prominent projection of posterior extremity; from *M. kelseyi*, which closely resembles it, by broader shell, and more oblique truncation of posterior extremity. Specimens identified by Dr. Dall.

Rather common in the lower San Pedro series at Deadman Island and San Pedro, and the upper San Pedro series at Los Cerritos, Long Beach, Crawfish George's, Deadman Island, and San Pedro. The upper San Pedro strata afford larger specimens, as a rule, than those found in the lower San Pedro.

Found also in the Pliocene at Pacific Beach, and in the Pleistocene at Spanish Bight and Pacific Beach, San Diego, and in the Pleistocene at Barlow's ranch, and the old ditch, Ventura.

The specimen figured is from the upper San Pedro series at San Pedro, and is now in the collection of Delos Arnold.

*Living.*—Alaska to San Diego; Kamtschatka (Cooper).

*Pleistocene.*—Santa Barbara to San Diego (Cooper): San Pedro; San Diego; Ventura (Arnold).

*Pliocene.*—Eagle Prairie and Danger Creek, Humboldt County; Santa Rosa; San Fernando (Cooper): San Diego (Arnold).

*Miocene.*—Sunol, Alameda County; Foxin's, Santa Barbara County (Cooper).

### 108. Macoma nasuta *Conrad* var. kelseyi *Dall.*

*Macoma kelseyi* DALL, Trans. Wagner Inst. Sci., Vol. III, Part 5, 1900, p. 1052, Pl. XLIX, fig. 7.

Shell of medium size, elongate-ovate, compressed, thin; posterior extremity cuneiform, obliquely truncated much above ventral margin; umbones nearly central; other characteristics same as in *M. nasuta.*

*Dimensions.*—Long. 70 mm.; alt. 45 mm.; diam. 18 mm.; umbo to anterior end 31 mm.; to posterior end 39 mm.

Distinguishable from other species by same characteristics that distinguish *M. nasuta;* distinguished from *M. nasuta* by narrower, flatter shell, and more oblique truncation of posterior end. Specimens identified by Dr. Dall.

Rare in the upper San Pedro series at San Pedro and Los Cerritos. Found also in the Pleistocene at Twenty-sixth Street, San Diego.

*Living.*—San Diego and south (Dall).

*Pleistocene.*—San Pedro; San Diego (Arnold).

### 109. Macoma secta *Conrad.*

PLATE XVI, FIG. 5.

*Tellina secta* CON., Jour. Phil. Acad. Sci., Vol. VII, 1837, p. 257. HANLEY, Thes. Conch., p. 337, Pl. LXV, figs. 245, 248, 1847.

*Macoma secta* CON., CARPENTER, Brit. Assn. Rept., 1863, p. 639. H. & A. ADAMS, Gen. Rec. Moll., p. 401, 1858. = *Tellina ligamentina* DESH. (*fide* GABB, Pal. Cal., Vol. II, p. 73, 1869). COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 249. KEEP, West Coast Shells, p. 191, fig. 163, 1892. WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 185.

*Macoma* (*Rexithærus*) *secta* CON. = var. *edulis* (NUTT. mss.) CPR. (*fide* DALL, Trans. Wagner Inst. Sci., Vol. III, Part 5, 1900, p. 1053).

Shell large, suboval, slightly ventricose, rather thin; umbones subcentral, evenly rounded anteriorly; posterior end truncated obliquely much above the base line; posterior dorsal margins short, straight, sloping off quite steeply to angle where it meets line of truncation; fold prominent; surface sculptured by lines of growth; two cardinal teeth in each valve; ligament short, thick, inserted on an elongated, oblique, rib-like callus; margin beneath the gape appearing as if cut or broken; pallial sinus large, expanded within, not reaching to anterior muscle-impression.

*Dimensions.*—Long. 82 mm.; alt. 65 mm.; diam. 24 mm.

Distinguishable by large size, broad shell, subcentral umbones, equal convexity of valves, and the prominent short ligamental callus. Resembles a *Mactra* somewhat in outline. Specimens identified by Dr. Dall.

Found in the lower San Pedro series at Deadman Island and San Pedro; and in the upper San Pedro series at Deadman Island, Los Cerritos, Crawfish George's, San Pedro, and Long Beach. Found also in the Pleistocene at Spanish Bight, San Diego. The specimen figured is from the upper San Pedro series at San Pedro, and is now in the collection of Delos Arnold.

*Living.*—Bodega Bay to San Diego; Japan (Cooper).

*Pleistocene.*—Santa Barbara to San Diego (Cooper): San Pedro; San Diego (Arnold).

*Pliocene.*—Santa Barbara; San Fernando (Cooper).

### 110. Macoma yoldiformis *Carpenter.*

PLATE XVI, FIG. 6.

*Macoma yoldiformis* CPR., Brit. Assn. Rept. 1863, p. 639. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 249. DALL, Trans. Wagner Inst. Sci., Vol. III, Part 5, 1900, p. 1053.

Shell small, subelliptical, compressed, very thin and fragile; umbones slightly posterior to center; anterior end evenly rounded, longer than posterior side, which is very faintly folded, biangular and more cuneiform; surface smooth, except for very fine incremental lines; ligamental area scooped out about one-half length of posterior end; teeth very small.

*Dimensions.*—Long. 23 mm.; alt. 13.2 mm.; diam. 6 mm.; umbo to anterior extremity 13 mm.; to posterior extremity 10 mm.

This species is distinguishable from other members of the genus by its small size, subelliptical form, very thin, smooth shell, posterior umbones and faint fold; distinguishable from *Tellina bodegensis* by less cuneiform posterior end and smaller size. Specimens identified by Dr. Dall.

Rare in the lower San Pedro series at Deadman Island. Rather common in the Pleistocene at Spanish Bight, San Diego. The specimen figured is from this locality, and is now in the collection of Delos Arnold.

*Living.*—Straits of Fuca to San Pedro (Cooper).

*Pleistocene.*—Santa Barbara (Cooper): San Pedro; San Diego (Arnold).

## Family XXXI. SEMELIDÆ.

### Genus **Semele** *Schumacher.*

Shell rounded, subequilateral, beaks turned forwards; posterior side slightly folded; hinge teeth two in right valve and two in left; laterals elongated, distinct in the right valve; external ligament short, cartilage internal, long, oblique; pallial sinus deep, rounded.

Type, *Tellina reticulata* Spengler.

### 111. Semele decisa *Conrad.*

*Amphidesma decisa* CON., Jour. Phil. Acad. Sci., Vol. VII, 1837, p. 234, Pl. XIX, fig. 2.
*Semele decisa* CON., CARPENTER, Proc. Zool. Soc., 1856, p. 213. CARPENTER, Brit. Assn. Rept., 1863, p. 640. GABB, Pal. Cal., Vol. II, p. 94, 1869. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 264. KEEP, West Coast Shells, p. 190, 1892. WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 186. DALL, Trans. Wagner Inst. Sci., Vol. III, Part 5, 1900, p. 995.

Shell rounded, subequilateral, thick; beaks elevated, turned forward; posterior side shorter than the anterior, direct, biangulated; fold distinct; anterior end evenly rounded; anterior dorsal margin slightly depressed; surface with numerous, thick, concentric, rugose, slightly prominent ribs; cartilage-process oblique; cardinal teeth obsolete; lateral teeth distinct; pallial sinus wide and shallow.

*Dimensions.*—Long. 8.5 mm.; alt. 78 mm.; diam. 34 mm.

The specimen described is a large one. These shells are often found in pairs in these deposits. Specimens identified by Dr. Dall.

Rare in the lower San Pedro series at San Pedro; common in the upper San Pedro series at Los Cerritos, but rarer in the same horizon at Deadman Island and San Pedro. Found also in the Pleistocene at Twenty-sixth Street, San Diego.

*Living.*—Santa Barbara to San Diego (Cooper).

*Pleistocene.*—San Pedro (Cooper; Arnold): San Diego (Arnold).

### 112. Semele pulchra *Sowerby.*

PLATE XV, FIGS. 1 AND 1*a*.

*Amphidesma pulchra* SBY., Conch., Vol. III, No. 2, fig. 2.

*Semele pulchra* SBY., CARPENTER, Brit. Assn. Rept., 1863, p. 640. GABB, Pal. Cal., Vol. II, p. 94, 1869. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 264. KEEP, West Coast Shells, p. 190, 1892. WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 186. DALL, Trans. Wagner Inst. Sci., Vol. III, Part 5, 1900, p. 995.

Shell small, oval, thin; beaks turned forward; posterior sides shorter than the anterior, slightly biangular; fold not very distinct; anterior dorsal margin slightly convex; anterior end evenly rounded; surface sculptured with numerous fine, sharp concentric ridges, and fine radiating striations; interior as in *S. decisa* except more delicate, and cardinal tooth in each valve prominent.

*Dimensions.*—Long. 22 mm.; alt. 18.2 mm.; diam. 6 mm.

Distinguishable from *S. decisa* by smaller, thinner shell, finer concentric sculpture and radiating striations. Specimens of the species in the State Museum Collection at the University of California, Berkeley, are labeled *S. flavescens* Gld. Specimens identified by Dr. Dall.

Rather rare in the upper San Pedro series at San Pedro and Los Cerritos. Found also in the Pleistocene at Twenty-sixth Street, San Diego. The specimen figured is from the upper San Pedro series at San Pedro, and is now in the collection of Delos Arnold.

*Living.*—Santa Barbara to San Diego; Acapulco to South America (Cooper).

*Pleistocene.*—San Pedro (Cooper; Arnold): San Diego (Cooper; Arnold).

### 113. Semele pulchra *Sowerby*, montereyi, var. nov.

PLATE XV, FIGS. 4 AND 4*a*.

Shell small, oval, ventricose, thin; beaks quite posterior to middle of shell; anterior dorsal margin long, nearly straight; anterior extremity evenly curved; posterior end much shorter than anterior, evenly rounded; fold obsolete; cartilage-process deep, oblique; one prominent cardinal tooth in each valve; lateral teeth distinct; pallial sinus very large, rounded, expanded interiorly.

*Dimensions.*—Long. 23 mm.; alt. 17.5 mm.; diam. 11.5 mm.

Resembles *S. pulchra* in size, but is much more oval, lacking the angular appearance at the beak; the beaks are situated more anteriorly in var. *montereyi* and the shell is much more ventricose. Easily differentiated from the typical *S. pulchra*. Pronounced a new variety of *pulchra* by Dr. Dall.

Rare in lower San Pedro series at Deadman Island.

The specimen figured is not the type, which is larger, and is in the United States National Museum. The specimen figured came from the lower San Pedro series at Deadman Island, and is now in the collection of Delos Arnold.

*Living.*—Monterey (Dall).

*Pleistocene.*—San Pedro (Arnold).

### Genus **Cumingia** *Sowerby.*

Shell transversely oval, equivalve, rounded in front, subrostrated and slightly gaping behind; small, thin, often irregular in form; hinge with a spoon-shaped cartilage-pit, and a small anterior cardinal tooth in each valve; two elongated lateral teeth in the right valve, less developed in the left; beaks small; surface concentrically ridged; pallial sinus very wide.

Type, *Cumingia mutica* Sowerby.

#### 114. **Cumingia californica** *Conrad.*

*Cumingia californica* CON., Jour. Phil. Acad. Sci., Vol. VII, 1837, p. 234, Pl. XVII, fig. 12. CARPENTER, Brit. Assn. Rept., 1863, p. 640. GABB, Pal. Cal., Vol. II, 1869, p. 94. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 238. KEEP, West Coast Shells, p. 196, fig. 168, 1892. WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 186. =*C. similis* A. AD. (*fide* DALL, Trans. Wagner Inst. Sci., Vol. III, part 5, 1900, p. 1001).

Shell of medium size, transversely oval, slightly ventricose, thin; umbones small, inconspicuous; anterior margin evenly rounded; posterior sloping from umbo at an angle of about 45 degrees, straight; posterior end somewhat obliquely truncated; surface sculptured by numerous, about equidistant, sharp, narrow, concentric ridges or frills; hinge with a triangular, spoon-shaped cartilage-pit and a small anterior cardinal tooth in each valve; two elongated lateral teeth in right valve, less developed in the left; pallial sinus very wide, expanded interiorly and deep.

*Dimensions.*—Long. 24.5 mm.; alt. 18 mm.; diam. 4.9 mm.

Resembles *Macoma nasuta* in general outline, but is easily distinguishable by the sharp, concentric ridges. Specimens identified by Dr. Dall.

Found in the lower San Pedro series at Deadman Island and San Pedro, and in the upper San Pedro series at Deadman Island, Crawfish George's, and San Pedro.

*Living.*—Monterey to San Diego; Mazatlan (Cooper): Japan (Stimson).

*Pleistocene.*—Santa Barbara; San Diego (Cooper): San Pedro (Arnold).

## Family XXXII. PSAMMOBIIDÆ.

### Genus **Psammobia** *(Lamarck) Bowdich.*

#### Subgenus **Psammobia** *s. s.*

Shell elongated, more or less pointed behind; compressed; somewhat rudely concentrically sculptured; the posterior dorsal area frequently sculptured diversely from the disc; the pallial sinus elongated and for the most part coalescent below with the pallial line.

Type, *Psammobia feroënsis* Gmel.

### 115. Psammobia (Psammobia) edentula *Gabb.*

*Silequaria edentula* GABB, Pal. Cal., Vol. II, p. 53, Pl. XV, fig. 11, 1869. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 264.
*Psammobia edentula* GABB, DALL, Trans. Wagner Inst. Sci., Vol. III, Part 5, 1900, p. 976.

Shell large, elongated, subelliptical, flattened, thin; beaks minute, posterior to middle; surface marked by distinct lines of growth most prominent near the margin; cardinal margins straight, sloping gently toward the ends; anterior end convexly and very obliquely subtruncate above, produced and rounded below; posterior end broadly and regularly rounded, a little less prominent below than above the middle; basal margin nearly straight; ligamental area long, projecting prominently beyond the cardinal line for nearly half the length of the anterior portion of the shell; projected area with large groove on outside, flat on inside; two prominent cardinal teeth, anterior less prominent and oblique; anterior muscle-impression large, subcircular; posterior smaller, subelliptical; pallial sinus deep and wide.

*Dimensions.*—Long. 135 mm.; alt. 69 mm.; diam. 13 mm.

This fine shell was originally described by Gabb from a specimen obtained in the Pliocene of San Fernando. On account of the matrix in which his specimen was imbedded, the hinge area and interior were only partly accessible, hence it was deemed expedient to more fully describe the interior of the shell. Dr. Dall pronounced the shell described above a member of the genus *Psammobia*. The cardinal teeth, however, are rather large for one of this genus.

Rare in the upper San Pedro series of San Pedro; three good specimens obtained.

*Living.*—?

*Pleistocene.*—San Pedro (Arnold).

*Pliocene.*—San Fernando (Cooper).

## Genus **Sanguinolaria** *Lamarck.*

### Section *Nuttallia Dall.*

Shell large, suborbicular, inequivalve, more or less twisted, the right valve slightly flatter; the posterior cardinal in the left valve obsolete; the pallial sinus narrow in front and somewhat detached from the pallial line.

Type, *Sanguinolaria nuttalli* Conrad.

### 116. Sanguinolaria (Nuttallia) nuttalli *Conrad.*

*Sanguinolaria nuttalli* CON., Jour. Phil. Acad. Sci., Vol. VII, 1837, p. 230, Pl. XVII, fig. 6. CARPENTER, Brit. Assn. Rept., 1863, p. 638. KEEP, West Coast Shells, p. 198, fig. 170, 1892. WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 185. DALL, Trans. Wagner Inst. Sci., Vol. III, Part 5, 1900, p. 979.

Shell large, subovate, thin; right valve ventricose, left compressed; umbones small, distant from anterior margin, slightly prominent, acute; surface smooth, except for fine incremental lines; anterior dorsal margin sloping concavely; posterior end evenly rounded from beaks; anterior end more sharply rounded and much more produced; ventral margin evenly curved; cardinal teeth prominent, fragile; ligamental area prominently projecting beyond cardinal line.

*Dimensions.*—Long. 80 mm.; alt. 59 mm.; diam. 23 mm.

Distinguishable from *Macoma* by the prominent ligamental projection, hinge, and less angular aspect. Specimens identified by Dr. Dall.

Rather rare in the upper San Pedro series at San Pedro and Los Cerritos.

*Living.*—Santa Barbara to San Diego (Carpenter).

*Pleistocene.*—San Pedro (Arnold).

### Genus **Tagelus** *Gray.*

Beaks median or subposterior; teeth two in each valve, simple, pedunculate; valves without constriction or clavicle, straight; pallial sinus deep, reaching to or beyond the beaks; posterior adductor scar rounded; pallial sinus with the ventral part partially coalescent with the pallial line.

Type, *Solen gibbus* Spengler.

#### 117. **Tagelus californianus** *Conrad.*

*Solecurtus californianus* CON., Jour. Phil. Acad. Sci., Vol. VII, 1837, p. 233, Pl. XVIII, fig. 3. CARPENTER, Brit. Assn. Rept., 1863, p. 638. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 265. Keep, West Coast Shells, p. 201, fig. 172, 1892.

*Tagelus californianus* CON., DALL, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 184. DALL, Trans. Wagner Inst. Sci., Vol. III, Part 5, 1900, p. 984.

Shell of medium size, oblong-oval, convex, thin; umbones about central; posterior dorsal margin runs straight back from umbo parallel with base; anterior dorsal margin slightly depressed, beginning a little below and in front of umbo, parallel with base; extremities evenly rounded; basal margin slightly contracted in middle; ligamental area slightly projecting; cardinal teeth, two in each valve, sharp and thin; pallial sinus long and wide, pointed.

*Dimensions.*—Long. 80 mm.; alt. 22 mm.; diam. 13 mm.

Specimens identified by Dr. Dall.

Rare in the lower San Pedro series at Deadman Island and San Pedro; common in the upper San Pedro series at Deadman Island, Los Cerritos, Crawfish George's, San Pedro, and Long Beach. Also found in the Pleistocene at Twenty-sixth Street, San Diego.

*Living.*—Santa Barbara to San Diego (Cooper).

*Pleistocene.*—Santa Barbara; San Pedro; San Diego (Cooper): San Pedro; San Diego (Arnold).

*Pliocene.*—San Diego (Dall).

### Family XXXIII. DONACIDÆ.

### Genus **Donax** *(Linné) Lamarck.*

Shell elongate, smooth, with no posterior carination; ventral margins with obsolete serration; cardinal teeth two in each valve, the larger often bifid; laterals both in the left valve, the anterior hardly distinguishable from the margin, of which it is a sort of modification.

*Donax trunculus* Linné is a characteristic species.

### 118. Donax californica *Conrad.*

PLATE XIII, FIG. 9.

*Donax californica* CON., Jour. Phil. Acad. Sci., Vol. VII, 1837, p. 254, Pl. XIX, fig. 21; (not of CARPENTER, Brit. Assn. Rept., 1863, p. 640.); (not of COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 238); (not of KEEP, West Coast Shells, p. 192, fig. 164, 1892); (not of WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 186). = *D. navicula* HANLEY (*fide* DALL, Trans. Wagner Inst. Sci., Vol. III, Part 5, 1900, p. 968).

*Donax flexuosus* (not of GOULD, Bost. Jour. Nat. Hist., Vol. VI, 1857, p. 394, Pl. XV, fig. 8); (not of CPR., Brit. Assn. Rept., 1863, p. 640). ? COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 238. KEEP, West Coast Shells, p. 192, 1892. ? WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 186.

Shell small, elongate-oval, rather pointed at both ends, thin; anterior end produced, quite sharply rounded; posterior portion over one-half length of anterior, rounded end; surface obscurely sculptured with fine radiating furrows; concentric, incremental sculpture sometimes visible; hinge and teeth as in *D. lævigata* except more delicate; interior of margin finely crenulated.

*Dimensions.*—Long. 18 mm.; anterior portion 11 mm.; posterior 7 mm.; alt. 8 mm.; diam. 6 mm.

Distinguishable from *D. lævigata* by smaller, narrower, thinner shell, more elongated posterior portion and much less steeply sloping dorsal margin on this end. This is the true *D. californica* Conrad, and not the *californicus* of Carpenter and other later writers (see synonymy above). Specimens identified by Dr. Dall.

Rare in the lower San Pedro series at Deadman Island and San Pedro; and in the upper San Pedro series at San Pedro. The specimen figured is from the lower San Pedro series at Deadman Island, and is now in the collection of Delos Arnold.

*Living.*—Santa Barbara to San Diego (Cooper).

*Pleistocene.*—San Pedro (Arnold).

### 119. Donax lævigata *Deshayes.*

PLATE XIII, FIG. 8.

*Donax lævigata* DESHAYES, Proc. Zool. Soc., 1854, p. 352. REEVE, Conch. Icon., Vol. VIII, Pl. V, fig. 31. DALL, Trans. Wagner Inst. Sci., Vol. III, Part 5, 1900, p. 969.

*Donax californicus* (not of CONRAD, Jour. Phil. Acad. Sci., Vol. VII, 1837, p. 254, Pl. XIX, fig. 21). CARPENTER, Brit. Assn. Rept., 1863, p. 640. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 238. KEEP, West Coast Shells, 192, fig. 164, 1892. WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 186.

*Donax obesus*, GLD., Proc. Bost. Soc. Nat. Hist., Vol. IV, 1851, p. 90; Bost. Jour. Nat. Hist., Vol. VI, p. 394, Pl. XV, fig. 9, 1857.

Shell rather small, trigonal, convex, wedge-like, closed; anterior portion produced, rounded, upper margin straight; posterior portion very short and dorsal margin nearly straight, also angulated at base; surface obscurely sculptured by fine radiating lines; incremental sculpture generally visible; interior of margin strongly crenulated; hinge teeth two in each valve; laterals one anterior and one posterior in each valve; pallial sinus deep.

*Dimensions.*—Long. 20.5 mm.; anterior portion 14 mm.; posterior 6.5 mm.; alt. 12 mm.; diam. 8 mm.

This is the common *Donax* of the West Coast, and is easily recognized by its triangular shape and the short, straight, posterior end. This species has been erroneously called *californicus* by Carpenter and others since then, but a comparison of one of these shells with Conrad's original figure and description of *californica* readily shows the error. The true *californica* Conrad has a rather produced and rounded posterior end, and is much narrower than *lævigata*. Specimens identified by Dr. Dall.

Rare in the lower San Pedro series at San Pedro and Deadman Island; common in the upper San Pedro series at San Pedro, Los Cerritos, Crawfish George's, Long Beach, and Deadman Island. Found also in the Pleistocene at Barlow's ranch, Ventura; and at Spanish Bight, Twenty-sixth Street, and Pacific Beach, San Diego. The specimen figured is from the upper San Pedro series at San Pedro, and is now in the collection of Delos Arnold.

*Living.*—Monterey?; San Luis Obispo to San Diego (Cooper).

*Pleistocene.*—San Pedro to San Diego (Cooper): San Pedro; San Diego; Ventura (Arnold).

## Superfamily SOLENACEA.

## Family XXXIV. SOLENIDÆ.

### Genus **Solen** *Linné.*

Hinge with one cardinal in each valve; beaks nearly anterior; external surface polished; valves usually straight.

Type, *Solen marginatus* Pulteney.

#### 120. **Solen rosaceus** *Carpenter.*

*Solen* (*sicarius* ? var.) *rosaceus* CPR., Brit. Assn. Rept., 1863, p. 638; Ann. & Mag. Nat. Hist., 3rd Ser., Vol. XV, 1865, p. 177.

*Solen rosaceus* CPR., GABB, Pal. Cal., Vol. II, p. 88, 1869. COOPER, 7th Ann. Rept. Cal. St. Min., 1888. p. 265. KEEP, West Coast Shells, p. 202, 1892. WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 184. DALL, Trans. Wagner Inst. Sci., Vol. III, Part 5, 1900, p. 952.

Shell of medium size, long, subcylindrical, slightly falcate, margins parallel, ends gaping; beaks terminal; anterior extremity evenly rounded, projecting furthest a little below the middle; posterior extremity very long, evenly rounded; hinge-teeth, one in each valve; ligament long, external; anterior muscle-impressions elongated; posterior oblong; sinus with squarish corners.

*Dimensions.*—Long. 55 mm.; alt. 10.5 mm.; diam. 6 mm.

This species much resembles *S. sicarius* but is much longer and narrower, more cylindrical, and has a much more evenly rounded and less abruptly truncated anterior extremity. Found also in the Pleistocene at Spanish Bight, San Diego.

*Living.*—Santa Barbara south to Gulf of California (Dall).

*Pleistocene.*—Santa Barbara (Cooper): San Pedro (Arnold): San Diego (Dall; Arnold).

*Pliocene.*—Santa Rosa; San Ramon, Kirker's Pass, Contra Costa County; San Fernando; San Diego well (Cooper).

*Miocene.*—Tomales, Marin County; Martinez, Contra Costa County (Cooper).

### 121. Solen sicarius *Gould.*

*Solen sicarius* GLD., Proc. Bost. Soc. Nat. Hist., Vol. III, 1850, p. 214; Wilkes' Expl. Exped., Vol. XII, p. 287, fig. 501, 1852. CARPENTER, Brit. Assn. Rept., 1863, p. 638. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 265. KEEP, West Coast Shells, p. 202, fig. 173, 1892. WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 184. DALL, Trans. Wagner Inst. Sci., Vol. III, Part 5, 1900, p. 952.

Shell of medium size, elongated, transversely oblong, cylindrical, slightly falcate; beaks terminal; anterior extremity truncate obliquely at angle of about 30 degrees, somewhat everted, the portion posterior to a line across from the beak to the base, concave; posterior extremity rounded; dorsal edge rectilinear; ventral edge regularly arcuate; surface undulated by lines of growth; hinge with single, erect, recurved, triangular tooth in each valve.

*Dimensions.*—Long. 63 mm.; alt. 16 mm.; diam. 9 mm.

Distinguishable by its terminal beak and rather falcate outline. Specimens identified by Dr. Dall.

Rather rare in the Pleistocene at Deadman Island and Timm's Point; common in the lower San Pedro series at Deadman Island and San Pedro; rare in the upper San Pedro series at Los Cerritos, San Pedro, Crawfish George's, and Deadman Island.

*Living.*—Straits of Fuca to San Pedro; Japan (Cooper).

*Pleistocene.*—San Pedro (Arnold).

*Pliocene.*—Twelve Mile Creek, San Mateo County; San Fernando (Cooper).

*Miocene.*—Walnut Creek, Contra Costa County (Cooper).

## Genus **Siliqua** *Megerle.*

Shell smooth, oblong; epidermis polished; an umbonal rib extending across the interior of the valve; pallial sinus short.

Type, *Solen radius* Linné.

### 122. Siliqua lucida *Conrad.*

*Solecurtus lucida* CON., Jour. Phil. Acad. Sci., Vol. VII, 1837, p. 232, Pl. XVII, fig. 9; = *S. radiata* LINN. (*fide* CONRAD, Jour. Phil. Acad. Sci., 1849, p. 214). DALL, Solenidæ, Proc. U. S. Nat. Mus., Vol. XXII, 1900, p. 109.

*Siliqua lucida* CON., DALL, Trans. Wagner Inst. Sci., Vol. III, Part 5, 1900, p. 957.

Shell of medium size, oblong-oval, compressed, thin, fragile; umbo a little less than one-fourth length from posterior end; interior raised callus sharp, narrow, perpendicular to dorsal margin; other characteristics the same as in var. *nuttalli.*

*Dimensions.*—Long. 32 mm.; alt. 12 mm.; diam. 5 mm.; umbo to anterior end 25 mm.; to posterior end 7 mm.

This species is distinguishable from var. *nuttalli* by its small size, fragile shell, more posterior umbo, and sharper, narrower, shorter, and more nearly perpendicular interior callus. Dr. Dall in his paper on the Solenidæ says that Carpenter (Brit. Assn. Rept., 1863, p. 634) and Gabb (1868) have confounded the young of *S. nuttalli* with this species. A large series of *S. lucida* from the Pleistocene shows the above mentioned differentiating characteristics to be constant. Specimens identified by Dr. Dall.

Rather rare in the lower San Pedro series at Deadman Island and San Pedro; and in the upper San Pedro series at San Pedro and Los Cerritos. Found also in the Pleistocene at Twenty-sixth Street and Spanish Bight, San Diego.

*Living.*—Monterey to San Diego (Dall).

*Pleistocene.*—San Pedro; San Diego (Arnold).

### 123. Siliqua patula (*Dixon*) var. nuttalli *Conrad.*

*Solecurtus nuttalli* CON., Jour. Phil. Acad. Sci., Vol. VII, 1837, page 232, Pl. XVII, fig. 9.
*Machæra patula*, not of DIXON, Voy. Around the World, p. 335, fig. 2, 1789. CARPENTER, Brit. Assn. Rept., 1863, p. 638 (in part). GABB, Pal. Cal., Vol. II, p. 89, 1869 (in part). COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 248 (in part). ? KEEP, West Coast Shells, p. 201, fig. 171, 1892.
*? Siliqua patula* DIXON, WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 185.
*Siliqua nuttalli* CON., = *S. californica* CON. (*fide* DALL, Trans. Wagner Inst. Sci., Vol. III, Part 5, 1900, p. 956).

Shell large, oblong-oval, compressed, thin, fragile; umbones a little over one-fourth length from posterior end, minute; anterior end more acutely rounded than posterior; ligamental area prominent, projecting beyond an equally long depression in the anterior dorsal margin; cardinal teeth in right valve, four in the left; a strong, elevated callus extends over half way across the interior of the shell from the umbo at nearly right angles with the dorsal margin.

*Dimensions.*—Long. 101 mm.; alt. 39 mm.; diam. 14 mm.

Distinguishable from *S. lucida* by larger, heavier shell; distinguished from *Tagelus californianus* by the posterior position of the beaks, and by the more rounded extremities. Specimens identified by Dr. Dall.

Rare; a nearly perfect pair from the upper San Pedro series at San Pedro. Found also in the Pleistocene at Spanish Bight, San Diego.

*Living.*—Mouth of the Columbia River (Conrad).

*Pleistocene.*—San Pedro; San Diego (Arnold).

*Pliocene.*—? Localities.

*Miocene.*—? Localities.

## Superfamily MACTRACEA.

## Family XXXV. MACTRIDÆ.

### Subfamily *MACTRINÆ.*

#### Genus Mactra *Linné.*

Shell nearly equilateral; anterior hinge-tooth A-shaped, with sometimes a small laminar tooth close to it; lateral tooth doubled in the right valve; ligament set off by a shelly lamina rising between chondrophore and ligament; cardinals generally coalescent above; laterals smooth or finely granular.

Type, *Mactra stultorum* Linné.

#### 124. Mactra californica *Conrad.*

PLATE XIX, FIG. 2.

*Mactra californica* CON., Jour. Phil. Acad. Sci., Vol. VII, 1837, p. 240, Pl. XVIII, fig 12. WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 187. DALL, Trans. Wagner Inst. Sci., Vol. III, Part 4, 1898, p. 876.

*Standella californica* CON., CARPENTER, Brit. Assn. Rept., 1863, p. 640. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 265. KEEP, West Coast Shells, p. 190, 1892.

Shell of medium size, subtrigonal, subequilateral, compressed, thick; umbones subcentral, turned anteriorly, margin only slightly arcuate; posterior side with a narrow, submarginal fold; posterior extremity quite sharply rounded; anterior dorsal line slightly depressed in front of umbones; anterior extremity evenly rounded; ventral margin evenly arcuate; surface sculptured with fine concentric lines; cartilage pit triangular, deep, separated from posterior ligamental groove by a ridge; cardinal teeth sharp, narrow, prominent; anterior ligamental groove long, narrow, with prominent interior margin; pallial sinus rather deep, rounded, not coinciding with ventral line.

*Dimensions.*—Long. 38 mm.; alt. 26 mm.; diam. 14 mm.; umbones to anterior extremity 17 mm.; to posterior extremity 21 mm.

The shell described was a small left valve, the only one so far obtained in the San Pedro Pleistocene. This species closely resembles *Spisula falcata*, but may be distinguished from that species by its thicker shell, more obtusely rounded anterior end, which gives it a less trigonal outline, and by the ridge which separates the posterior ligamental groove from the cartilage pit. Distinguishable from other species occurring in these beds by its almost central umbo, which turns slightly toward the front. Several specimens of the young of this species show prominent concentric undulations, reminding one somewhat of a small *Rœta undulata.*

Specimens identified by Dr. Dall. (Cooper makes *M. californica* and *M. planulata* synonymous, and under this heading reports the species from several localities in the Pleistocene, Pliocene and Miocene; but until his two forms are differentiated it would be useless to give his localities.)

Rare in upper San Pedro series of San Pedro; one specimen found, which is figured, and is now in the collection of Delos Arnold. Common in the Pleistocene at Twenty-sixth Street, San Diego.

*Living.*—San Francisco to San Diego (Carpenter).

*Pleistocene.*—San Pedro; San Diego (Arnold).

### 125. Mactra exoleta *Gray*.

PLATE XIX, FIG. 4.

*Mactra exoleta* GRAY, = *Lutraria ventricosa* GLD. (*fide* CARPENTER, Proc. Zool. Soc., 1856, p. 200).

Shell of medium size, decidedly trigonal, ventricose, thin, fragile; umbones slightly anterior to center, elevated, not touching, turned only slightly forward; anterior dorsal margin straight; anterior extremity evenly rounded near base; ventral margin evenly arcuate; posterior dorsal margin arcuate, making an acute angle with the ventral margin; a sharp, prominent, angular ridge runs from umbo to the posterior extremity; surface sculptured with fine, incremental lines, which are most prominent posterior to ridge; cartilage-pit deep; hinge-teeth lamellar, long; ligamental groove very deep and narrow.

*Dimensions.*—Long. 56 mm.; alt. 43 mm.; diam. 30 mm.; umbo to anterior extremity 23 mm.; to posterior extremity 33 mm.

Distinguishable from others of genus by the sharply angular trigonal shape, great convexity, elevated umbo, and sharp, submarginal posterior ridge. Specimen identified by Dr. Dall.

Rare in upper San Pedro series of San Pedro; one nearly perfect right valve, which is figured, and is now in the collection of Delos Arnold. Found also in the Pleistocene at Spanish Bight and Pacific Beach, San Diego.

*Living.*—Coast of Mexico (Carpenter).

*Pleistocene.*—San Pedro; San Diego (Arnold).

### 126. Mactra hemphilli *Dall*.

PLATE XIX, FIG. 3.

*Mactra hemphilli* DALL, Nautilus, Vol. VII, 1894, p. 137, Pl. V.

Shell large, subtrigonal, subequilateral, convex, rather thin; umbones slightly elevated, subcentral, turned slightly forward; anterior portion hollowed in front of umbo, making the dorsal margin slightly concave; anterior end evenly rounded; posterior dorsal margin evenly arcuate, making a shorter turn into the ventral margin than does the anterior dorsal margin; posterior end most produced near base; a prominent angular submarginal fold runs from the umbo to the posterior extremity; hinge same as in *M. californica*, except that the anterior ligamental groove is much shorter; pallial sinus of medium size, very oblique.

*Dimensions.*—Long. 123 mm.; alt. 100 mm.; diam. 62 mm.; umbo to anterior extremity 50 mm.; to posterior extremity 73 mm.

This species is distinguishable from *M. californica* by its greater altitude, more concave anterior dorsal margin, shorter anterior ligamental groove, and oblique pallial sinus; one of its unique characteristics being the oblique sinus. Specimen identified by Dr. Dall.

Rare in upper San Pedro series of San Pedro; one specimen, which is figured, and is now in the collection of Delos Arnold.

*Pleistocene.*—San Pedro (Arnold).

### Subgenus **Spisula** *Gray*.

Mactræ with ligament sagittate, set in a callous area close to the dorsal margin, and not set off from the chondrophore by any shelly ridge.

Type, *Mactra solida* (Linn.) Gray.

### 127. Mactra (Spisula) catilliformis *Conrad.*

PLATE XIX, FIG. 5.

Shell large, subtrigonal, slightly ventricose, rather thin; umbones slightly anterior to center, marginal, not prominent; a long, rather narrow, hollowed submarginal space in front of umbo; anterior dorsal margin straight; anterior extremity evenly rounded near middle of shell; posterior margin sharp, nearly straight; posterior extremity more obtusely rounded than anterior; ventral margin prominently and evenly arcuate; surface sculptured with fine incremental lines; posterior submarginal fold very faint; cartilage-pit large, triangular, very prominent; cardinal teeth not prominent; laterals narrow, short; anterior ligamental area not separated from cartilage-pit; pallial sinus horizontal, rather broad and shallow.

*Dimensions.*—Long. 125 mm.; alt. 98 mm.; diam. 54 mm.; umbo to anterior extremity 50 mm.; to posterior extremity 75 mm.

Distinguishable by its large size, broad, almost oval outline, prominent cartilage pit, long, depressed area in front of umbo, and nearly equally rounded ends. Specimen identified by Dr. Dall.

Rather common in the upper San Pedro series at San Pedro, Los Cerritos, Crawfish George's, and Deadman Island. Found also in the Pliocene at Pacific Beach, and in the Pleistocene at Pacific Beach, Spanish Bight and Twenty-sixth Street, San Diego; and in the Pleistocene at Barlow's ranch, Ventura. The specimen figured is from the upper San Pedro series at San Pedro, and is now in the collection of Delos Arnold.

*Living.*—West Coast.

*Pleistocene.*—San Pedro; San Diego; Ventura (Arnold).

*Pliocene.*—San Diego (Arnold).

### 128. Mactra (Spisula) falcata *Gould.*

PLATE XIX, FIG. 1.

*Mactra falcata* GLD., Proc. Bost. Soc. Nat. Hist., Vol. III, 1850, p. 216; Wilkes' Expl. Exped., Vol. XII, p. 393, fig. 506, 1852.

*Standella falcata* GLD., CARPENTER, Brit. Assn. Rept. 1863, p. 640. GABB, Pal. Cal., Vol. II, p. 92, 1869. =*S. nasuta* GLD. (*fide* COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 266). KEEP, West Coast Shells, p. 188, 1892.

*Mactra planulata* var. *falcata* GLD., WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 187.

Shell of medium size, transversely ovate-triangular, convex, rather thin; umbones about central, elevated; anterior dorsal margin nearly straight; anterior extremity rounded near base; ventral margin subarcuate; posterior dorsal margin slightly arcuate, and in left valve forming a slight angle behind umbo; posterior extremity not quite as sharply rounded as anterior extremity; submarginal posterior ridge rounded, not prominent; hinge as in *catilliformis*, except cartilage-pit less prominent; pallial sinus rather long, with rounded extremity, horizontal; two broad, flat ridges radiate from umbo on interior surface, forming a long, triangular depression between them.

*Dimensions.*—Long. 41 mm.; alt. 28 mm.; diam. 15 mm.

Distinguishable from other species by narrower, more acutely rounded anterior end, and interior radiating ridges. Resembles *M. californica*, but is distinguishable

by smaller pallial sinus, lack of ridge between cartilage-pit and anterior ligamental groove, and by the interior radiating ridges and narrower anterior end. Specimens identified by Dr. Dall.

Found in the lower San Pedro series at San Pedro and Deadman Island; and in the upper San Pedro series at San Pedro, Deadman Island, Crawfish George's and Los Cerritos. Also found in Pleistocene at Spanish Bight, San Diego. The specimen figured is from the upper San Pedro series at San Pedro, and is now in the collection of Delos Arnold.

*Living.*—Kodiak, Alaska, to San Diego (Cooper).

*Pleistocene.*—San Pedro (Arnold): San Diego (Cooper; Arnold).

*Pliocene.*—Eagle Prairie, Humboldt County; Kirker's Pass, Contra Costa County (Cooper).

*Miocene.*—Martinez; Half Moon Bay, San Mateo County; Sunol, Alameda County; Siebeck's, Santa Clara County; Griswold's, San Benito County; Foxin's, Santa Barbara County; Santiago, Los Angeles County (Cooper).

### Subfamily PTEROPSIDINÆ.

### Genus **Labiosa** (*Schmidt*) *Möller.*

Shell large, thin, inflated, broad and gaping behind, beaks adjacent; surface concentrically striate; dorsal areas well defined; pallial sinus short, rounded, wide; ligament marginal, set off by a prominent lamina of shell from the pit; a single obsolete and very short lateral in each valve before and behind the pit; hinge-plate flattish behind, depressed and excavated in front.

Type, *Mactra anatina* Spengler.

### Subgenus **Ræta** *Gray.*

Shell acutely rostrate behind; dorsal areas obscure, the surface of the valves more or less vermiculate; pallial sinus deep, narrow, pointed; ligament submerged, except at the anterior end, set off by a shelly ridge which roofs the apex of the pit, and partially supports the posterior arm of the cardinal tooth; left cardinal small; right cardinal with anus coalescent above; a single anterior and posterior lateral in each valve.

Type, *Lutraria canaliculata* Say.

#### 129. **Labiosa (Ræta) undulata** *Gould.*

*Lutraria undulata* GLD., Proc. Bost. Soc. Nat. Hist., Vol. IV, 1851, p. 89; Bost. Jour. Nat. Hist., Vol. VI, 1853, p. 391, Pl. XV, fig. 7.
*Ræta undulata* GLD., CARPENTER, Brit. Assn. Rept., 1863, p. 640.
*Lutraria transmontana* CON. (*fide* COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 247) [in part].

Shell of medium size, ovate, ventricose, thin; beaks a little anterior to center; anterior broadly rounded and tumid; posterior narrowed, compressed and acutely rounded, the dorsal margin being a rectilinear slope, gaping; surface concentrically undulated; cardinal tooth strong; posterior lateral tooth small.

The above description was taken from Gould. A small fragment of a shell showing the undulation of this species was found in the lower San Pedro series of Deadman Island. This fragment may have been of a young of *Panopea generosa*, which is undulated in much the same way as *Rœta*. Cooper likens this species to Conrad's *Lutraria transmontana* from the "Pliocene of Los Angeles County." One perfect valve from the Pleistocene at Spanish Bight, San Diego. There is no doubt as to the identity of the Spanish Bight specimen.

*Living.*—San Pedro to Lower California (Carpenter).

*Pleistocene.*—San Pedro? (Arnold): San Diego (Arnold).

### Subfamily *LUTRARIINÆ.*

### Genus **Tresus** *Gray.*

Shell large, inequilateral, thin, inflated; siphonal gape very large, pedal gape narrow; ligament minutely sagittate, separated by a shelly lamina from the pit, which lamina is often recurved and patulous; left cardinal high, compressed; laterals small but distinct in both valves; right cardinal feeble.

Type, *Tresus nuttalli* Conrad.

#### 130. **Tresus nuttalli** *Conrad.*

*Lutraria (Cryptodon) nuttalli* Con., Jour. Phil. Acad. Nat. Sci., Vol. VII, 1837, p. 225, Pl. XVIII, fig 1.
*Schizothœrus nuttalli* Con., Pac. R. R. Rep., Vol. V, p. 234, Pl. IV, fig. 33, 1853. Cpr., Brit. Assn. Rept., 1863, p. 637, = *Lutraria maxima* Midd., = *Mactra maxima* (Midd.) Rve., = *Lutraria capax* Gld., = *Tresus maximus* (Midd.) H. & A. Adams (*fide* Gabb, Pal. Cal., Vol. II, p. 91, 1869). Tryon, Syst. Conch., Vol. III, p. 161, Pl. CX, fig. 21, 1884. Cooper, 7th Ann. Rept. Cal. St. Min., 1888, p. 264. Keep, West Coast Shells, p. 205, 1892. Williamson, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 183.
*Tresus nuttalli* Con., Dall, Trans. Wagner Inst. Sci., Vol. III, Part 4, 1898, p. 885.

Shell large, subelliptical, convex, equivalve, inequilateral, thin; umbones small, anterior to center; anterior dorsal margin evenly arcuate, sloping to anterior extremity, which is furthest produced below the middle; posterior aperture truncated, gaping; surface sculptured by prominent lines of growth; one small cardinal tooth in each valve; cartilage-pit large, deep, triangular, separated from ligamental groove by ridge; pallial sinus very large, broad, reaching nearly to line perpendicular to beak.

*Dimensions.*—Long. 103 mm.; alt. 73 mm.; diam. 44 mm.; umbo to anterior extremity 35 mm.; to posterior extremity 68 mm.

Externally the young of this species resemble somewhat the young of *Saxidomus*, but may be distinguished by the thinner, slightly gaping shell, and prominent cartilage-pit. Specimens identified by Dr. Dall.

Common in the upper San Pedro series at San Pedro, Los Cerritos, Crawfish George's, and Deadman Island. Found also in the Pleistocene at Spanish Bight, San Diego.

*Living.*—Alaska to San Diego (Cooper): both sides of North Pacific (Dall).

*Pleistocene.*—Santa Barbara to San Diego (Cooper): San Pedro; San Diego (Arnold).

*Pliocene.*—Santa Barbara (Cooper).

## Superfamily MYACEA.

## Family XXXVI. MYACIDÆ.

### Genus **Platyodon** *Conrad.*

Shell ventricose, with concentric, undulating striæ, and a small groove from the apex to the ventral margin; posterior side short, radiately striated; spoon-shaped cardinal process dilated and bi-emarginate.

Type, *Platyodon cancellatus* Conrad.

#### 131. **Platyodon cancellatus** *Conrad.*

*Mya cancellatus* CON., Jour. Acad. Nat. Sci., Phil., Vol. VII, 1837, p. 236, Pl. XVIII, fig. 2.
*Platyodon cancellatus* CON., CPR., Brit. Assn. Rept., 1863, p. 637. TRYON, Syst. Conch., Vol. III, Pl. CVI, fig. 28, 1884. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 260. KEEP, West Coast Shells, p. 208, fig. 177, 1892. WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 183. DALL, Trans. Wagner Inst. Sci., Vol. III, Part 4, 1898, p. 858.

Shell of medium size, subelliptical, ventricose, thin; surface sculptured by numerous fine, concentric laminæ of growth, and anterior portion with numerous fine radiating striæ, which are obsolete on the anterior portion; a slight furrow extends from the beak to the base; umbo prominent; anterior end truncated and gaping; posterior end rounded; cardinal tooth very erect, dilated, bi-emarginate.

*Dimensions.*—Long. 49 mm.; alt. 28 mm.; diam. 22.5 mm.

Although belonging to the *Myacidæ*, this species has somewhat the shape of a *Pholas*, but may be distinguished by its sculpture. Most of the specimens found were in pairs, and in a fine state of preservation. Specimens identified by Dr. Dall.

Rather rare in the upper San Pedro series at Deadman Island, San Pedro, Los Cerritos, and Crawfish George's.

*Living.*—Bolinas Bay to San Diego (Cooper).

*Pleistocene.*—? Santa Cruz (Cooper): San Pedro (Arnold).

### Genus **Cryptomya** *Conrad.*

Shell inequilateral, transverse, oblong, gaping behind; valves with concentric striæ; right valve with a lamellar tooth; left valve with a broad fosset; ligament internal; pallial sinus absent or obsolete.

Type, *Cryptomya californica* Conrad.

### 132. Cryptomya californica *Conrad.*

*Sphœnia californica* Con., Journ. Phil. Acad. Nat. Sci., Vol. VII, 1837, p. 234, Pl. XVII, fig. 11. Cpr., Proc. Zool. Soc., 1856, p. 210.

*Cryptomya californica* Con., Proc. Phil. Acad. Nat. Sci., 1849, p. 121. Cpr., Brit. Assn. Rept., 1863, p. 637, =*C. ovalis* Con. (*fide* Gabb, Pal. Cal. Vol. II, p. 90, 1869). Cooper, 7th Ann. Rept. Cal. St. Min., 1888, p. 237. Keep, West Coast Shells, p. 205, 1892. Williamson, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 183. Dall, Trans. Wagner Inst. Sci., Vol. III, Part. 4, 1898, p. 859.

Shell rather small, subelliptical, convex, equivalve, subequilateral, thin; anterior extremity biangular, with faint fold running down from umbo to lower portion of this extremity; posterior extremity evenly rounded, slightly more produced below middle; ventral margin slightly arcuate; surface sculptured by numerous fine, concentric, incremental lines; right valve with prominent lamellar tooth, in which is a shallow cartilage-pit or chondrophore; left valve with a broad fosset; pallial sinus obsolete.

*Dimensions.*—Long. 26.5 mm.; alt. 18 mm.; diam. 5 mm.

Distinguishable from young of *Tresus nuttalli* by the lamellar elevated tooth and obsolete sinus. Specimens identified by Dr. Dall.

Found in the lower San Pedro series at Deadman Island and San Pedro; and in the upper San Pedro series at San Pedro, Deadman Island, Los Cerritos, Crawfish George's, and Long Beach. Found also in the Pleistocene at Twenty-sixth Street and Spanish Bight, San Diego; and at the old irrigating ditch and Barlow's ranch, Ventura.

*Living.*—British Columbia to Lower California (Dall).

*Pleistocene.*—San Pedro (Arnold): San Diego well (Cooper): San Diego; Ventura (Arnold).

*Pliocene.*—Santa Rosa; Twelve Mile House, San Mateo County; Soquel, Santa Cruz County; San Fernando; San Diego well (Cooper).

*Miocene.*—Siebeck's, Santa Clara County; Griswold's, San Benito County; Foxin's, Santa Barbara County (Cooper).

## Family XXXVII. CORBULIDÆ.

### Genus **Corbula** *(Bruguière) Lamarck.*

Valves unequal, the right usually larger, both more or less rostrate; hinge with (in the right valve) a single large tooth below the beak, with a deep resiliary pit behind it, and no lateral laminæ; the left valve without laterals, with a process upon which the resilium and ligament are inserted, in front of a socket, into which the cardinal tooth of the right valve fits; beaks prominent; sculpture variable, never strongly radial; pallial line with a small sinus or none; lunule and escutcheon usually absent; ligament chiefly internal.

*Corbula gallica* Lam. is a characteristic species.

### 133. Corbula luteola *Carpenter.*

PLATE XVII, FIG. 11.

*Corbula luteola* CPR., Brit. Assn. Rept., 1863, p. 637. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 236. KEEP, West Coast Shells, p. 204, 1892. WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 183. DALL, Trans. Wagner Inst. Sci., Vol. III, Part IV, 1898, p. 856.

Shell small, subelliptical, gibbose, thick; beaks, subcentral, small, inconspicuous; anterior extremity evenly rounded; posterior dorsal margin slightly arcuate, sloping down nearly to base, where it turns abruptly, forming an angular extremity; ventral margin arcuate; a sharp submarginal ridge extends from beak to lower portion of posterior extremity; surface sculptured with fine, but distinct, concentric ridges; right valve with one prominent cardinal tooth in front of cartilage-pit; left valve smaller, with a projecting cartilage process; pallial sinus slight; pedal scar distinct from adductor impressions.

*Dimensions.*—Long. 8 mm.; alt. 5.5 mm.; diam. 3.5 mm.

This species is distinguishable by its peculiar shape, the sharp posterior, submarginal ridge, and the delicate sculpture. Specimens identified by Dr. Dall.

Found in the Pliocene at Deadman Island; in the lower San Pedro series at Deadman Island and San Pedro; and in the upper San Pedro series at San Pedro and Los Cerritos. Also found in the Pleistocene at Twenty-sixth Street, San Diego.

The specimen figured is from the lower San Pedro series at Deadman Island, and is now in the collection of Delos Arnold.

*Living.*—San Pedro to San Diego (Cooper).

*Pleistocene.*—San Pedro (Arnold): San Diego (Cooper; Arnold).

*Pliocene.*—San Pedro (Arnold).

## Genus **Neæra** *Gray.*

Shell globular, attenuated, and gaping posteriorly; right valve a little the smallest; umbone strengthened internally by a rib on the posterior side; cartilage-process spatulate, in each valve, with an obsolete tooth in front, and a posterior lateral tooth; pallial sinus very shallow.

*Neæra ornatissima* Irb. is a characteristic species.

### 134. Neæra pectinata *Carpenter.*

PLATE XVIII, FIG. 11.

*Neæra pectinata* CPR., Brit. Assn. Rept., p. 637, 1863.

Shell small, globular, attenuated and gaping behind, thin; umbones anterior; dorsal line straight; anterior extremity evenly rounded; posterior extremity drawn out to a very long, narrow, truncated beak; ventral margin greatly arcuate; surface sculptured by twelve prominent, sharp, radiating ridges; posterior elongation smooth; cartilage-process spatulate, with an obsolete tooth in front.

*Dimensions.*—Long. 6.5 mm.; alt. 3.4 mm.; diam. 2.3 mm.; umbo to anterior extremity 2.5 mm.; to posterior extremity 4 mm.

This unique little shell is distinguishable by its prominent radiating sculpture and wing-like posterior projection. Specimen identified by Dr. Dall.

One nearly perfect right valve from the lower San Pedro series at Deadman Island was obtained by Mrs. Oldroyd, is figured in this paper, and is now in the collection of Mrs. Oldroyd. Later another valve was found at the same locality by Delos Arnold.

*Living.*—Puget Sound to Santa Barbara, 40 to 60 fathoms (Carpenter).

*Pleistocene.*—San Pedro (Oldroyd; Arnold).

## Family XXXVIII. SAXICAVIDÆ.

### Genus **Panopea** *Ménard.*

Shell equivalve, thick, oblong, gaping at each end; ligament external, on prominent ridges; one prominent tooth in each valve; pallial sinus deep.

*Mya glycymeris* Born. is a characteristic species.

#### 135. **Panopea generosa** *Gould.*

*Panopea generosa* GLD., Proc. Bost. Soc. Nat. Hist. Vol. III, 1850, p. 215. Wilkes' Exped., p. 385, Pl. XXXIV, fig. 507, 1852.

*Glycimeris generosa* GLD., H. & A. ADAMS, Gen. Rec. Moll., p. 350, 1853. CPR., Brit. Assn. Rept., 1863, p. 637. GABB, Pal. Cal., Vol. II, p. 89, 1869. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 241. KEEP, West Coast Shells, p. 209, fig. 178, 1892. WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 183. DALL, Wagner Inst. Sci., Vol. III, Part 4, 1898, p. 830.

"Shell large, rather thin, nearly equilateral, the beaks slightly anterior, the dorsal and ventral margins in the full grown shell parallel and nearly straight, the pedal margin evenly rounded, the nymph narrow, and the attached edge of the ligament very short; the pallial sinus wide and shallow.

"*Dimensions.*—Long. 182 mm.; alt. 110 mm.; diameter 60 mm."

Dr. Dall gives the above description of a living, typical *P. generosa* Gould from Puget Sound. In the same paper (Tertiary Fauna of Florida, Trans. Wagner Inst. Sci., Vol. III, Part 4, p. 831) he describes two new varieties of this same species which he thinks have constant differences enough to warrant the separation. Variety *solida* Dall has a heavy, somewhat arcuate, shell, strong nymph, a ligamentary attachment twice as long as in the typical form, and a deep pallial sinus. This and the typical form are found from Puget Sound to San Diego. Variety *globosa* Dall has a short, thin, inflated shell with the beaks nearer the anterior end, which is expanded and rounded in the pedal region; opposite margins not parallel; pallial sinus small and wide. Found at head of Gulf of California.

Dall also classes together *Mya abrupta* Con. and *Glycimeris estrellana* Con., of the Miocene of California and Oregon, and differentiates them from *P. generosa* Gld. under the name *P. estrellana* Con.

Two imperfect valves from the upper San Pedro series at Los Cerritos were identified by Dr. Dall as typical *P. generosa.*

Rare in the Pliocene and lower San Pedro series at Deadman Island; and in

the upper San Pedro series at Deadman Island, San Pedro, and Los Cerritos. Found in the Pliocene at Packard's Hill, Santa Barbara.

*Living.*—Puget Sound to San Diego (Dall).

*Pleistocene.*—Santa Barbara to San Diego (Cooper): San Pedro (Arnold).

*Pliocene.*—Santa Barbara; San Fernando (Cooper): San Pedro; Santa Barbara (Arnold).

Genus **Panomya** *Gray.*

Shell solid, large, irregular, with a single cardinal tooth under the beak in each valve; the pallial line of unconnected rounded impressions.

Type, *Panopea* (*Mya*) *norvegica* Spengler.

### 136. Panomya ampla *Dall.*

*Panomya ampla* DALL, Trans. Wagner Inst. Sci., Vol. III, Part 4, 1898, p. 833.
*Panopea norvegica* MIDD. (pars.) Mal. Ross., Vol. III, p. 78, Pl. XX, fig. 11, 1849 (not of SPENGLER) (*fide* DALL).

Shell large, irregularly subquadrate, ventricose, thick; beaks subcentral, incurved, small, sharp, elevated; anterior extremity rounded, projected furthest above middle; posterior extremity gaping, abruptly and irregularly truncated, with angular corners above and below; basal margin nearly rectilinear; two large folds separate the shell into three parts; one fold extends to the lower posterior angle from the umbo, and the other extends to the lower anterior angle from the umbo; surface roughly sculptured by concentric lines and undulations; one small cardinal tooth in each valve; cartilage-process rather short, projecting; pallial line of unconnected, rounded impressions.

*Dimensions.*—Long. 55 mm.; alt. 38 mm.; diam. 27 mm.

This species reminds one somewhat of a young *Panopea generosa*, but is distinguishable from that species by the more central beaks, shorter and more irregular shell, two prominent folds, and unconnected pallial line. Specimens identified by Dr. Dall.

Rare in the Pliocene at Deadman Island; several perfect valves found.

*Living.*—North Pacific, Behring and Okhotsk Seas (Dall).

*Pleistocene.*—North Pacific, Behring and Okhotsk Seas (Dall).

*Pliocene.*—San Pedro (Arnold).

## Superfamily ADESMACEA.

## Family XXXIX. PHOLADIDÆ.

### Subfamily *PHOLADINÆ.*

Genus **Zirphæa** *Leach.*

Shell oval, cardinal margin scarcely reflected; no accessory valves, the beaks protected by a membrane; usually a thin, fugacious epidermis; anteriorly greatly gaping.

Type, *Pholas crispata* Linné.

### 137. Zirphæa gabbii *Tryon.*

*Zirphæa gabbii* TRYON, Proc. Phil. Acad. Nat. Sci., 1866, p. 144, Pl. I, fig. 1. GABB, Pal. Cal., Vol. II, pp. 52, 88, Pl. XV, fig. 10, 1869. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 270. DALL, Trans. Wagner Inst. Sci., Vol. III, Part 4, 1898, p. 818.

*Zirphæa crispata* (non LINN., Syst. Nat., Ed. X, p. 670, 1859) (*fide* DALL). CPR., Brit. Assn. Rept., 1863, p. 637. KEEP, West Coast Shells, p. 210, fig. 179, 1892. WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 182.

Shell of medium size, oblong, convex, thin; surface sculptured by concentric laminations, which are much more elevated, and are provided with sharp, rasp-like teeth on the anterior half of the shell; a slightly raised ridge, flanked by two shallow depressions, runs obliquely posteriorly from the umbo, dividing the spiny sculptured area from the concentrically ridged area; valve reflexed from the umbones forward, covering the umbones; each valve is provided with a delicate spoon-shaped tooth or process, which joins the shell just beneath the umbo.

*Dimensions.*—Long. 72 mm.; alt. 35 mm.; diam. 30 mm.

This species, though closely allied to *Z. crispata*, is pronounced a distinct species by Dr. Dall. Specimens identified by Dr. Dall.

Quite rare in the upper San Pedro series at San Pedro, Los Cerritos, Crawfish George's, and Deadman Island.

*Pleistocène.*—Santa Barbara (Cooper): San Pedro (Cooper; Arnold).

*Miocene.*—(?) Alameda County (Cooper).

## Subfamily *JOUANNETINÆ.*

### Genus **Pholadidea** *Goodall.*

Shell with a double anterior accessory plate (protoplax), the other plate present or absent, the valves prolonged behind into leathery or testaceous cups or a tube (siphonoplax) for the protection of the siphons.

Type, *Pholadidea loscombiana* Goodall.

### Subgenus **Pholadidea** *s. s.*

Shell with a double, rather small protoplax; the siphonoplax cup-like, the accessory plates wanting; a single radial sulcus.

Type, *Pholadidea loscombiana* Goodall.

### Section *Penitella Valenciennes.*

Like *Pholadidea*, but with a small mesoplax, the two parts of the protoplax confluent.

Type, *Pholas penita* Conrad.

### 138. Pholadidea (Penitella) penita *Conrad.*

*Pholas penita* CON., Jour. Phil. Acad. Nat. Sci., Vol. VII, 1837, p. 237, Pl. XVIII, fig. 7, +*P. concamerata* DESH., 1840, +*P. conradi* VAL., 1846 (*fide* DALL, Trans. Wagner Inst. Sci., Vol. III, Part 4, 1898, p. 819).

*Parapholas penita* CON., CPR., Proc. Zool. Soc., 1856, p. 210.

*Pholadidea penita* CON., CPR., Brit. Assn. Rept., 1863, p. 637. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 259. KEEP, West Coast Shells, p. 212, fig. 181, 1892. WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 182.

*Penitella penita* CON., TRYON, Proc. Phil. Acad. Nat. Sci., Monog. Pholad., 1861, p. 87.

*Penitella spelæa* CON. (*fide* GABB, Pal. Cal., Vol. II, p. 88, 1869).

Shell of medium size, globose-oblong, equivalve, inequilateral, thin; beaks anterior, small, covered by callous plate; transverse furrow from beak to middle of ventral margin; anterior portion of shell with concentric, wavy, lamellæ, which rise to sharp points on the crests of the undulations, the points, taken as a whole, giving the impression of rugose, radiating, raised lines; posterior portion of shell gaping, with surface concentrically sculptured; anterior gap large, closed in adult shell by callous plate; with a small mesoplax, the two parts of the protoplax confluent.

*Dimensions.*—Long. 35 mm.; alt. 21 mm.; diam. 20 mm.

Rather common in the upper San Pedro series of San Pedro, Los Cerritos, Crawfish George's, and Deadman Island.

*Living.*—Straits of Fuca to Santa Barbara (Cooper): San Pedro (Williamson).

*Pleistocene.*—Santa Barbara (Cooper): Harris' ranch, Santa Barbara County (Knecht): San Pedro (Arnold).

# Class SCAPHOPODA.[1]

## Order SOLENOCONCHIA.

### Family XL. DENTALIIDÆ.

#### Genus **Dentalium** *Linné.*

Shell tube-like, gradually tapering posteriorly; longitudinally ribbed; margin of the aperture sharpened; posterior end with an internal, slightly projecting tube, which is provided with a dorso-ventrally elongated opening, the outer layer having a very slight emargination dorsally and ventrally.

*Dentalium elephantinum* Linn. is a characteristic species.

#### 139. **Dentalium hexagonum** *Sowerby.*

*Dentalium hexagonum* SBY., Thes. Conch., Vol. III, p. 103, fig. 10. CARPENTER, Brit. Assn. Rept., 1863, p. 648. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 238. KEEP, West Coast Shells, p. 114, 1892. WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 194.

*Dentalium neohexagonum* SHARP & PILSBRY, Tryon's Man. Conch., Vol. XVII, p. 19, Pl. XI, figs. 74-86, 1898.

Shell small, curved, thin, tapering posteriorly; apex truncate; surface encircled by fine incremental lines and generally by one or two irregular encircling grooves showing interruption in growth; six prominent, equidistant, longitudinal ridges begin at posterior end and become obsolete near aperture; cross-section near posterior end, hexagonal; aperture subcircular.

*Dimensions.*—Long. 33 mm.; diam. 3 mm.

Somewhat resembles a miniature elephant's tusk in shape.

Rather common in the lower San Pedro series at Deadman Island and San Pedro; and in the upper San Pedro series at San Pedro, Deadman Island, Crawfish George's, Los Cerritos, and Long Beach. Found in the Pleistocene at Barlow's

[1] The classification adopted for this division is that used by Dr. W. N. Dall in Part II of the "Contributions to the Tertiary Fauna of Florida." The generic description is from Tryon's "Structural and Systematic Conchology."

ranch, Ventura; and in the Pliocene at Pacific Beach, and Russ School, and in the Pleistocene at Twenty-sixth Street, Spanish Bight, and Pacific Beach, San Diego.

*Living.*—Santa Barbara to Mexico; East Indies; China (Cooper).

*Pleistocene.*—Santa Barbara to San Diego (Cooper): San Pedro; San Diego; Ventura (Arnold).

*Pliocene.*—San Diego well (Cooper): San Diego (Arnold).

### 140. Dentalium indianorum *Carpenter.*

PLATE VIII, FIG. 4.

*Dentalium (? pretiosum* NUTT., SBY., var.) *indianorum* CPR., Brit. Assn. Rept., 1863, p. 648.
*Dentalium indianorum* CPR., COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 238.
*Dentalium pretiosum* var. *indianorum* CPR., TRYON, Man. Conch., Vol. XVII, p. 45, Pl. XIII, figs. 4, 5, 6, 8, 1898.

Shell small, curved, tapering posteriorly, heavy; surface with fine incremental rings, and striated posteriorly; cross-section and aperture circular.

*Dimensions.*—Long. 41 mm.; diam. 3 mm.

Some of the specimens are much more tapering than others. This species is distinguishable from other members of the genus found in this locality by its heavier shell, and by the striations near the posterior end. Specimens identified by Dr. Dall.

Not uncommon in the lower San Pedro series of San Pedro and Deadman Island; rare in the upper San Pedro series at Crawfish George's. The specimen figured is from the lower San Pedro series at Deadman Island, and is now in the collection of Delos Arnold.

*Living.*—Straits of Fuca to Santa Barbara (Cooper).

*Pleistocene.*—Santa Barbara (Cooper): San Pedro (Arnold).

### 141. Dentalium pseudohexagonum *Dall.*

PLATE VIII, FIGS. 12 AND 12*a*.

*Dentalium pseudohexagonum* DALL, mss.
*Dentalium neohexagonum* SHARP & PILSBRY., TRYON, Man. Conch., Vol. XVII, p. 19, 1898, Pl. XI, figs. 74-86.

Shell small, curved, tapering posteriorly, rather heavy; surface ornamented with nine prominent, rounded, elevated, longitudinal ridges, with concave interspaces; cross-section nine-sided; aperture round.

*Dimensions.*—Long. 28 mm.; anterior diam. 2.8 mm.; posterior diam. 1 mm.

Distinguishable from the other members of the genus by the number of the ridges. The specimen described was dark colored, whether natural or not is not known. Specimen identified by Dr. Dall.

Rare in the lower San Pedro series at Deadman Island; one fine specimen collected by Mrs. Oldroyd, and one by Delos Arnold; one or two specimens from

the upper San Pedro series at San Pedro. Found also in the Pleistocene at Spanish Bight, San Diego. The specimen figured is from the lower San Pedro series at Deadman Island, and is now in the collection of Mrs. T. S. Oldroyd.

*Living.*—Locality unknown. Reported by Dall.

*Pleistocene.*—San Pedro (Oldroyd; Arnold): San Diego (Arnold).

### 142. Dentalium semipolitum *Broderip & Sowerby.*

*Dentalium semipolitum* BROD. & SBY., CPR., Brit. Assn. Rept., 1863, p. 648. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 238.
*Dentalium semistriatum* var. *semipolitum* BROD. & SBY., TRYON, Man. Conch., Vol. XVII, p. 91, Pl. XVI, fig. 54, 1898.

Shell small, thin, tapering posteriorly, curved near posterior extremity; surface ornamented by numerous fine longitudinal ridges; cross-section and aperture circular.

*Dimensions.*—Long. 10 mm.; diam. 1.4 mm.

Distinguishable from *D. indianorum* by striations along the whole length, and smaller, thinner, and more tapering shell. Specimens identified by Dr. Dall.

Rare in upper San Pedro series at San Pedro, Deadman Island, and Crawfish George's.

*Living.*—San Diego to Gulf of California (Cooper).

*Pleistocene.*—San Pedro (Arnold).

*Pliocene.*—San Diego well (Dall).

### *Genus* Cadulus *Philippi.*

Shell short, more or less inflated in the middle; apical orifice entire, circular, with annular suboblique internal plica remote from the apex.

*Cadulus subfusiformis* Sars is a characteristic species.

### 143. Cadulus nitentior *Carpenter.*

PLATE VIII, FIG. 15.

*Cadulus nitentior* CPR., mss.
*Cadulus fusiformis* PHIL., COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 231.
*Cadulus fusiformis* SHARP & PILSBRY, DALL, mss.

Shell small, dingy white or lustrous, tapering, falcate, tubular, thin; surface sculptured by numerous incremental lines, and sometimes by slight constrictions; aperture circular.

*Dimensions.*—Long. 10 mm.; maximum diam. 1.2 mm.

Common in the lower San Pedro series at Deadman Island and San Pedro bluffs. Found in the Pleistocene at Spanish Bight, San Diego. The specimen figured is from the lower San Pedro series at Deadman Island, and is now in the collection of Delos Arnold.

*Living.*—California Coast.

*Pleistocene.*—San Pedro; San Diego (Arnold).

*Pliocene.*—San Diego well (Cooper).

# Class GASTROPODA.[1]

## Order OPISTHOBRANCHIATA.

### Family XLI. ACTÆONIDÆ.

#### Genus **Actæon** *Montfort.*

Shell solid, ovate, with a conical, many-whorled spire, spirally grooved or punctate-striate; aperture long, narrow, rounded in front; outer lip sharp; columella with a strong, tortuous fold.

*Tornatella fasciata* Lam. is a characteristic species.

**144. Actæon traskii** *Stearns.*

PLATE X, FIG. 6.

*Actæon traskii* STEARNS, Nautilus, Vol. XI, 1897, p. 14; Proc. U. S. Nat. Mus., Vol. XXI, 1899, p. 297, text-fig.

Shell small, conical above, cylindrical, rather solid; sculpture consisting of numerous fine, spiral, impressed lines, which become wider toward the base of the body-whorl, making the lower portion of the shell lirate, and by sharp, close-set, incremental lines; these latter are subordinate to the spiral sculpture; whorls six; suture distinct, narrowly channeled; aperture about two-thirds length of the shell, acutely angular above, rounded and effuse below, finely lirate and glossy within, with a thin glazing on the body-whorl; outer lip thin, simple; columella short and flexuous, with a conspicuous fold curving around the same and thickening the edge of the lip, which is moderately produced in the umbilical region.

*Dimensions.*—Long. 10 mm.; lat. 5.2 mm.; body-whorl 8.3 mm. aperture 7 mm.

Distinguishable from *Rictaxis punctocœlata* by its larger size, more impressed suture, more cylindrical body-whorl, more prominent and effuse anterior plication. Specimens identified by Dr. Dall. Rare in upper San Pedro series of San Pedro.

Found in the Pleistocene at Spanish Bight, from which locality it was originally described. The specimen figured is from the upper San Pedro series at San Pedro, and is now in the collection of Delos Arnold.

? *Living*—San Diego (Stearns).

*Pleistocene.*—San Pedro (Arnold): San Diego (Stearns; Hamlin; Arnold).

#### Subgenus **Rictaxis** *Dall.*

Shell like *Actæon*, but with the columella projecting beyond the line of the anterior margin, forming a small, tooth-like projection, or truncate obliquely.

Type, *Tornatella punctocœlata* Cpr.

[1] The classification of the Gastropoda is that used by Dall in Parts I and II of the "Contributions to the Tertiary Fauna of Florida," and in Bulletin No. 37, United States National Museum. The generic descriptions are for the most part from Tryon's "Structural and Systematic Conchology."

### 145. Actæon (Rictaxis) punctocœlata *Carpenter.*

PLATE IX, FIG. 6.

*Tornatella punctocœlata* CPR., Brit. Assn. Rept., 1863, p. 646; Jour. de Conch., Vol. XII, 1865, p. 139. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 267.

*Rictaxis punctocœlata* CPR., DALL, Am. Jour. Conch., Vol. VII, 1872, p. 136, Pl. XV, fig. 12. TRYON, Syst. Conch., Vol. II, p. 356, Pl. LXXXVII, fig. 28, 1883. KEEP, West Coast Shells, p. 125, fig. 115, 1892. WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 195. TRYON, Man. Conch., Vol. XV, p. 166, Pl. LXIX, fig. 24, 1893. STEARNS, Proc. U. S. Nat. Mus., Vol. XXI, 1899, p. 298.

Shell small, elongate, elliptical, thin; spire small, conical; whorls three or four, convex; sculpture consists of numerous fine, spiral impressed lines; body-whorl slightly ventricose; aperture acutely angular above, rounded below; outer lip thin, simple; columella projecting beyond the line of the anterior margin, or truncate obliquely; one sharp, columellar plait.

*Dimensions.*—Long. 6 mm.; lat. 2.7 mm.; body-whorl 5 mm.; aperture 3.5 mm.

Distinguishable from *Actæon traskii* by projecting columella, more ventricose body-whorl, less effuse anterior lip, and smaller size.

Rare in the lower San Pedro series at Deadman Island and San Pedro, and in the upper San Pedro series at San Pedro. Found also in the Pleistocene at Spanish Bight, San Diego. The specimen figured is from the upper San Pedro series at San Pedro, and is now in the collection of Delos Arnold.

*Living.*—Santa Cruz to San Diego (Cooper).

*Pleistocene.*—Santa Barbara to San Diego (Cooper): San Pedro (Arnold); San Diego (Stearns; Arnold).

## Family XLII. TORNATINIDÆ.

### Genus **Tornatina** *A. Adams.*

Shell cylindrical or fusiform, spire conspicuous, apex sinistral, suture channeled, columella callous, single plaited.

*Tornatina coarctata* A. Adams is a characteristic species.

### 146. Tornatina cerealis *Gould.*

PLATE X, FIG. 5.

*Bulla (Tornatina) cerealis* GLD., Bost. Jour. Nat. Hist., Vol. VI, 1853, p. 278, Pl. XIV, fig. 9.

*Tornatina cerealis* GLD., CPR., Brit. Assn. Rept., 1863, p. 647. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 267. TRYON, Man. Conch., Vol. XV, p. 188, Pl. L, figs. 39, 40, 1893.

Shell minute, solid, ovoid-fusiform, white; spire prominent, of three or four whorls rising by regular grades, and mammillate at tip; aperture linear above, gradually widening forward; outer lip salient at middle, and very gradually approaching the body of the whorl posteriorly, unites to it before reaching the suture; columellar margin callous its whole length, with a strong fold at the base.

*Dimensions.*—Long. 4.5 mm.; lat. 2 mm.; spire 5 mm.; aperture 3.5 mm.

Distinguishable from *T. culcitella* by more angular whorls, mammillate apex, more keeled upper edge of whorl, and smaller size. Specimens identified by Dr. Dall.

Rather common in the upper and lower San Pedro series at San Pedro, and in the lower San Pedro series at Deadman Island. Found also in the Pleistocene at Spanish Bight, San Diego. The specimen figured is from the lower San Pedro series at Deadman Island, and is now in the collection of Delos Arnold.

*Living.*—Monterey to San Diego (Cooper).

*Pleistocene.*—Santa Barbara; San Diego (Cooper): San Pedro; San Diego (Arnold).

### 147. Tornatina culcitella *Gould.*

PLATE X, FIG. 3.

*Bulla (Akera) culcitella* GLD., Bost. Jour. Nat. Hist., Vol. VI, 1853, p. 377, Pl. XIV, fig 8: Mex. & Cal. Shells, p. 14, Pl. XIV, fig. 8, 1853.

*Tornatina culcitella* GLD., CPR., Proc. Zool. Soc., 1856, p. 227. CPR., Brit. Assn. Rept., 1863, p. 646. GABB, Pal. Cal., Vol. II, p. 88, 1869. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 268. KEEP, West Coast Shells, p. 125, fig. 114, 1892. WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 195. TRYON, Man. Conch., Vol. XV, p. 189, Pl. L, fig. 38, 1893.

Shell small, thin, cylindrical, narrowed posteriorly; spire only slightly elevated; apex acute; whorls four or five, suture appressed, distinct; aperture nearly as long as body-whorl, narrow anteriorly, gradually widening anteriorly to near anterior end, where it quite suddenly retracts to columella; columella with one plait.

*Dimensions.*—Long. 11 mm.; lat. 5 mm.; body-whorl 10 mm.; aperture 8.5 mm.

Some specimens attain the length of 23 mm.

Common in the upper and lower San Pedro series of San Pedro and vicinity. Found also in the Pleistocene at bath-house, Santa Barbara; at Barlow's ranch, Ventura, and at Twenty-sixth Street and Spanish Bight, San Diego. The specimen figured is from the lower San Pedro series at Deadman Island, and is now in the collection of Delos Arnold.

*Living.*—Monterey to San Diego (Cooper).

*Pleistocene.*—Santa Barbara (Cooper): San Pedro; Santa Barbara; Ventura; San Diego (Arnold).

### 148. Tornatina eximia *Baird.*

PLATE X, FIG. 11.

*Tornatina eximia* BAIRD, Proc. Zool. Soc., 1863, p. 67. CPR., Brit. Assn. Rept., 1863, p. 647. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 268. TRYON, Man. Conch., Vol. XV, p. 189, 1893.

Shell resembles *T. culcitella*, but differs from that species in the following respects: Has a whorl less narrowed anteriorly, a spire depressed nearly to rim of body-whorl, a longer and narrower aperture, and a less prominent plait on the columella.

*Dimensions.*—Long. 12.4 mm.; lat. 5.5 mm.; body-whorl 12.2 mm.; aperture 11.5 mm.

Specimen identified by Dr. Dall.

One specimen from the Pliocene at Deadman Island which is figured, and is now in the collection of Delos Arnold.

*Living.*—Vancouver Island to San Diego (Cooper).

*Pleistocene.*—San Diego (Cooper).

*Pliocene.*—San Diego well (Cooper): San Pedro (Arnold).

### 149. Tornatina harpa *Dall.*

*Tornatina harpa* DALL, Am. Jour. Conch., Vol. VII, 1872, p. 136, Pl. XV, fig. 11. KEEP, West Coast Shells, p. 125, 1892.

Shell small, white, of four and a half whorls; tabulate and sharply carinate above, characterized by sharp grooves and raised lines, parallel with the lines of growth, which extend half over the whorls and become obsolete anteriorly; apex mammillated, minute globular, prominent; suture canaliculated; anterior portion of the last whorl smooth; last whorl slightly narrower above; aperture long, narrow, effuse below, with a deep, narrow sinus at the suture; columellar plait obsolete in the adult, rather prominent in the young shells; carina intersected by the grooves and slightly dentate.

*Dimensions.*—Long. 6 mm.; lat. 3 mm.

Easily distinguishable by the longitudinal sculpture on the upper half of the last whorl.

Rare in the upper and lower San Pedro series at San Pedro. Found in upper San Pedro series at Spanish Bight, San Diego.

*Living.*—Monterey (Dall): Catalina Island, 10 fathoms (Arnold, 1901).

*Pleistocene.*—San Pedro; San Diego (Arnold).

## Genus **Volvula** *A. Adams.*

Shell subcylindrical, attenuated to a point posteriorly, to which the narrow aperture extends; spire concealed; outer lip sharp; columella with an obsolete anterior plication.

*Volvula acuminator* Brug. is a characteristic species.

### 150. Volvula cylindrica *Carpenter.*

PLATE IV, FIG. 2.

*Volvula cylindrica* CPR., Brit. Assn. Rept., 1863, p. 647; Ann. & Mag. Nat. Hist., 3rd Ser., Vol. XV, 1865, p. 380. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 270. WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 195. TRYON, Man. Conch., Vol. XV, 1892, p. 239.

Shell small, cylindrical; flattened in middle and with margin almost parallel, swelling out anteriorly; suddenly narrowed behind, running out into short, narrow, umbilicated point; aperture length of shell; very narrow posteriorly, gradually broadening into subovate opening at anterior end; surface smooth, except for faint lines of growth parallel to margin of shell.

*Dimensions.*—Long. 11 mm.; maximum diam. 4.5 mm.

Resembles *Cylichna alba*, but has an extended umbilical point. Dall (Trans. Wagner Inst. Sci., Vol. III, Part 1, 1890, p. 16) mentions a "*Volvula cylindrica*

Gabb" as occurring in the Miocene of San Domingo, and living on the Atlantic Coast near Cape Hatteras. Whether or not this species is identical with the West Coast form the writer is unable to state.

Rare in the lower San Pedro series at Deadman Island. Found in the Pleistocene at Twenty-sixth Street, San Diego. The specimen figured is from the lower San Pedro series at Deadman Island, and is now in the collection of Delos Arnold.

*Living.*—Santa Barbara to San Diego (Cooper).

*Pleistocene.*—San Diego (Cooper): San Pedro; San Diego (Arnold).

## Family XLIII. SCAPHANDRIDÆ.

### Genus **Cylichna** *Loven.*

Shell strong, cylindrical, smooth or punctate-striate; spire minute or truncated; aperture narrow, rounded in front; columella callous, with one plait.

*Cylichna arachis* Quoy. is a characteristic species.

### 151. **Cylichna alba** *Brown.*

PLATE X, FIG. 18.

*Cylichna cylindracea* (non LINN.) CPR., Brit. Assn. Rept., 1863, p. 647. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 238.
*Volvaria alba* BROWN, Illustr. Conch. G. B., p. 3, Pl. XIX, figs. 43, 44.
*Cylichna alba* (BROWN) LOVEN, Öfversight K. Vet.-Akad, Förh., 1846, p. 142. TRYON, Man. Conch., Vol. XV, p. 290, Pl. LX, fig. 16, 1893.

Shell small, cylindrical, smooth; spire truncated; aperture narrow posteriorly for about two-thirds length of shell, when the inner lip gradually retracts to the columella, forming a rounded anterior end to the aperture; columella callous, with one plait.

*Dimensions.*—Long. 10.5 mm.; maximum diam. 4.25 mm.

Specimens identified by Dr. Dall.

Rare in the lower San Pedro series of Deadman Island, and upper San Pedro series at San Pedro.

Found also in the Pleistocene at Spanish Bight, San Diego, and at Barlow's ranch, Ventura. The specimen figured is from the lower San Pedro series at Deadman Island, and is now in the collection of Delos Arnold.

*Living.*—Monterey to San Diego (Cooper).

*Pleistocene.*—Santa Barbara; San Diego (Cooper): San Pedro; San Diego; Ventura (Arnold).

*Pliocene.*—San Diego well (Cooper).

## Family XLIV. BULLIDÆ.

### Genus **Bulla** *Linné.*

Shell oval-globular, smooth, spotted, marbled, or zoned; spire concave, umbilicated; aperture as long as the shell; inner margin without columella; outer lip trenchant.

*Bulla ampulla* Linn. is a characteristic species.

#### 152. **Bulla punctulata** *A. Adams.*

*Bulla punctulata* A. AD., Thes. Conch., Vol. II, p. 604. CPR., Proc. Zool. Soc., 1863, p. 359. TRYON, Man. Conch., Vol. XV, Pl. 37, fig. 39; Pl. XXXVI, figs. 29, 30, 1893.
*Bulla punctata* A. AD., Thes. Conch., Vol. II, p. 577, Pl. CXXIII, fig. 77; not of SCHROETER.
*Bulla adamsii* MENKE, Zeit. f. Mol., p. 162, 1850. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 230.

Shell of medium size, subglobular, thin; spire lacking; aperture full length of shell, broadly ovate in front, narrowed posteriorly; outer lip thin, simple, gradually rounded near umbilicus; inner lip and columella incrusted; umbilical pit at posterior end, deep, effuse.

*Dimensions.*—Long. 32 mm.; alt. 23 mm.; aperture 32 mm.

The shell described was an average specimen, some of the shells being larger and some much smaller. Specimens identified by Dr. Dall.

This species is distinguishable from *B. nebulosa* by its longer, narrower, more cylindrical body-whorl. *B. punctulata* is a southern shell, and is found but rarely as far north as San Diego. *B. nebulosa* is the common form now living at San Pedro.

Rather common in the upper San Pedro series of Deadman Island, Los Cerritos, Crawfish George's, and San Pedro.

*Living.*—San Pedro to Panama (Cooper).

*Pleistocene.*—San Pedro (Cooper; Arnold).

*Pliocene.*—San Fernando (Cooper).

#### 153. **Bulla quoyi** *Gray.*

PLATE VIII, FIG. 8.

*Bulla quoyi* GRAY, Trav. in New Zealand, Dieffenbach, Vol. I, p. 243, No. 113. CPR., Brit. Assn. Rept., 1863, p. 646.

Shell small, elliptical; aperture extending full length of shell; ovate in front, somewhat narrowed behind; outer lip thin, angulated at posterior end; umbilicus at posterior end deep, not very effuse; columella incrusted, the incrustation covering the anterior umbilical region.

*Dimensions.*—Long. 8 mm.; alt. 5 mm.; aperture 8 mm.

The specimen described is a young shell. Identified as *Bulla quoyi* by Dr. Dall. Distinguishable from *B. punctulata* by angulation of outer lip near posterior umbilicus, and the much sharper curve of the anterior lip.

Rare in upper San Pedro series of San Pedro; one young specimen found, which is figured, and is now in the collection of Delos Arnold.

*Living.*—Santa Barbara to Lower California (Carpenter).

*Pleistocene.*—San Pedro (Arnold).

Genus **Haminea** *Leach.*

Shell oval-globular, spiral ventricose, corneous, thin, covered by a slight, smooth epidermis; spire involute.

*Haminea hydatis* Linn. is a characteristic species.

### 154. Haminea virescens *Sowerby.*

PLATE VIII, FIG. 18.

*Bulla virescens* SBY., Gen. Rec. Moll., No. XXXIX, fig. 2. A. ADAMS, Thes. Conch., Vol. II, p. 579, Pl. CXXIV, fig. 83, 1850. CPR., Brit. Assn. Rept., 1863, p. 646. = *H. cymbiformis* CPR. (*fide* DALL, Trans. Wagner Inst. Sci., Vol. III, Part 1, 1890, p. 18). KEEP, West Coast Shells p. 126, 1892. WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 195. TRYON, Man. Conch., Vol. XV, p. 360, Pl. XL, fig. 5; Pl. XLIII, fig. 19, 1893.

Shell small, subglobular, thin; spire wanting; aperture full length of shell; posterior portion of lip projects only slightly beyond apex; anterior part of aperture broadly ovate, tapering into a canal at the posterior extremity; surface smooth and shell translucent.

*Dimensions.*—Long. 7 mm.; alt. 6 mm.; aperture 7 mm. × 4.5 mm.

One of the specimens shows the green color of the living shells. Dr. Dall says of this species: "The specimens (Caloosahatchie beds) have been compared with typical specimens of *H. virescens*, and agree exactly. This is one of the cases where, so far as known, a species formerly inhabiting both coasts of North America has become extinct since Pliocene times on one side of the continent while persisting on the other. It is quite possible, however, that a more thorough exploration of the Antillean region would show the species still living there."

Rare in upper San Pedro series of San Pedro; two specimens found. The specimen figured is from the upper San Pedro series at San Pedro, and is now in the collection of Delos Arnold.

*Living.*—Santa Barbara to San Diego (Carpenter).

*Pleistocene.*—San Pedro (Arnold).

*Pliocene.*—Caloosahatchie beds, Florida (Dall).

## Order PULMONATA.

## Suborder STYLOMMATOPHORA.

## Superfamily MONOTREMATA.

## Family XLV. HELICIDÆ.

Genus **Helix** *Linné.*

Subgenus **Epiphragmophora** *Strobel.*

Shell umbilicate, fusco-calcareous; peristome expanded, nearly circular; a solid calcareous epiphram.

*Helix cuyana* Strobel is a characteristic species.

### 155. Helix (Epiphragmophora) sp. indet.

Shell small, flattened, globosely conoidal; spire only slightly elevated; whorls three or four, slightly convex; umbilicus narrow, deep; peristome expanded, nearly circular.

An imperfect specimen of this genus was found in the lower San Pedro series and sent to Dr. Dall, who pronounced it a member of the above genus.

*Living.*—(?)

*Pleistocene.*—San Pedro (Arnold).

## Superfamily HYGROPHILA.

## Family XLVI. LIMNÆIDÆ.

### Subfamily *PLANORBINÆ.*

### Genus **Planorbis** *Guettard.*

Shell discoidal, biconcave, the whorls visible on both sides; aperture small, rounded; margin usually simple, sometimes expanded.

*Planorbis corneus* Linné is a characteristic species.

### 156. Planorbis tumidus *Pfeiffer.*

PLATE IX, FIG. 13.

*Planorbis tumidus* Pfeiff., Proc. Zool. Soc., 1861, p. 232. CPR., Brit. Assn. Rept., 1863, p. 558.

Shell small, discoidal; spire, except last one and three-fourths whorls, slightly depressed; whorls four, breadth and height about equal; suture deeply impressed, the whorls sloping toward it; base cup-shaped, exhibiting all of the whorls; aperture exhibiting a slightly oblique section of a somewhat angular cylinder; lip embracing over half of body-whorl and joined by callus.

*Dimensions.*—Alt. 5 mm.; maximum diam. 12 mm.

Distinguishable from *P. vermicularis* by less sloping upper side of body-whorl, less depressed spire, and lip that is not expanded. Specimens identified by Dr. Dall.

Rare in upper and lower San Pedro series of San Pedro; three specimens. The specimen figured is from the upper San Pedro series at San Pedro, and is now in the collection of Delos Arnold.

*Living.*—Guatemala (Carpenter).

*Pleistocene.*—San Pedro (Arnold).

### 157. Planorbis vermicularis *Gould.*

PLATE IX, FIG. 14.

*Planorbis vermicularis* GLD., Proc. Bost. Soc. Nat. Hist., Vol. II, 1847, p. 212; Wilkes' Expl. Exped., Vol. XII, p. 112, fig. 131, 1852. CPR., Brit. Assn. Rept., 1863, p. 675.

Shell small, dome-shaped; spire sunken into cup shaped depression below upper margin of body-whorl; whorls four, breadth and height about equal, the last one deflected near the aperture,

rounded at periphery; suture very deep, the whorls sloping toward it; base cup-shaped, exhibiting all of the whorls; aperture exhibiting a very oblique section of a cylinder; slightly expanded, embracing about one-half the height of the last whorl, and joined by callus.

*Dimensions.*—Alt. 6 mm.; maximum diam. 11.5 mm.

Specimens identified by Dr. Dall.

Rare in the upper and lower San Pedro series at San Pedro; three specimens. The specimen figured is from the upper San Pedro series at San Pedro, and is now in the collection of Delos Arnold.

*Living.*—Interior of Oregon (Gould).

*Pleistocene.*—San Pedro (Arnold).

## Family XLVII. PHYSIDÆ.

### Genus **Physa** *Draparnaud.*

Shell ovate, sinistrally spiral, thin, polished; aperture rounded in front.

*Physa fontinalis* Linn. is a characteristic species.

### 158. **Physa heterostropha** *Say.*

*Physa heterostropha* SAY, Nicholson's Encycl., Pl. LXIX, fig. 6. CPR., Brit. Assn. Rept., 1863, p. 674. KEEP, West Coast Shells, p. 118, fig. 107, 1892.

Shell small, sinistral, shining, pellucid; whorls five ventricose; suture distinct; aperture oval; outer lip thin; pillar lip strong and forms a conspicuous sinus where it joins the whorl above.

*Dimensions.*—Long. 12 mm.; lat. 7 mm.; body-whorl 10 mm.; aperture 8 mm.; defl. 95 degrees.

This fresh-water form, together with several other species having the same habitat, was found in the lower San Pedro beds at San Pedro. There is no doubt as to their occurrence in these marine deposits, into which they were probably washed by some fresh-water stream.

*Living.*—North America.

*Pleistocene.*—San Pedro (Arnold).

## Superfamily DITREMATA.

## Family XLVIII. AURICULIDÆ.

### Subfamily *MELAMPINÆ.*

### Genus **Melampus** *Montfort.*

Shell oval-conoidal, or suboval, solid; spire rather short; aperture elongated, narrow; columellar lip with several dentiform plications; columella plicate; outer lip sharp, interior with revolving ridges.

*Melampus luteus* Quoy is a characteristic species.

### 159. Melampus olivaceus *Carpenter.*

*Melampus olivaceus* CPR., Mazatlan Cat., No. 235; Brit Assn. Rept., 1863, p. 647. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 250. KEEP, West Coast Shells, p. 124, fig. 113, 1892. WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 196.

Shell small, thin, pyriform; spire solid, conical, barely elevated; whorls four or five, flat; body-whorl comprises most of shell, slightly angulated above; suture appressed, wavy; aperture long, narrow, rounded anteriorly; outer lip thin; inner lip incrusted, and with one prominent plication, and sometimes one or two more smaller ones; one prominent plication on columella; umbilicus subperforate.

*Dimensions.*—Long. 12 mm.; lat. 9 mm.; aperture 9.5 mm.

Somewhat resembles a small, thin, depressed *Conus californicus.*

Found in all of the lower and upper San Pedro localities. Also found in the Pleistocene at Twenty-sixth Street, San Diego.

*Living.*—Salinas River to Mazatlan (Cooper).

*Pleistocene.*—San Diego (Cooper): San Pedro; San Diego (Arnold).

*Pliocene.*—San Diego well (Dall).

## Superfamily PETROPHILA.

## Family XLIX. GADINIIDÆ.

### Genus **Gadinia** *Gray.*

Shell obliquely conical; muscular impression horseshoe-shaped, the right side shortest, terminating at the siphonal groove.

*Gadinia afra* Gray is a characteristic species.

### 160. Gadinia reticulata *Sowerby.*

*Mourctia reticulata* SBY., Proc. Zool. Soc., 1835, p. 6.
*Gadinia reticulata* SBY., H. & A. ADAMS, Gen. Rec. Moll., Vol. I, p. 463, 1853. CPR., Brit. Assn. Rept., 1863, p. 666. DALL, Am. Jour. Conch., Vol. VI, 1871, p. 11, Pl. II, figs. 1 to 9; Pl. IV, figs. 1, 2 and 3. KEEP, West Coast Shells, p. 98, fig. 83, 1892. WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 196.
*Rowellia* sp. CPR., Brit. Assn. Rept., 1863, p. 651.
*Gadinia (Rowellia) radiata* COOPER, GABB, Proc. Cal. Acad. Sci., Vol. III, 1865, p. 188. COOPER, Geogr. Catal. Moll., p. 24, No. 460, 1867.
*Rowellia radiata* COOPER, Am. Jour. Conch., Vol. VI, 1871, p. 319.
*Gadinia radiata* COOPER, DALL, Am. Jour. Conch., Vol. VII, 1872, p. 192.
*Gadinia reticulata* var. *radiata* COOPER, Bull. No. 4, Cal. St. Min. Bureau, 1894, p. 26.

Shell conical; apex central, smooth, blunt; surface sculptured by numerous rounded, radiating ridges, made somewhat nodose by concentric, elevated lines of growth; aperture slightly ovate; inner surface smooth; lip smooth, effuse; color white.

*Dimensions.*—Long. 15 mm.; lat. 14 mm.; alt. 5 mm.

Somewhat resembles *Acmæa mitra,* but is more depressed, has a less acute apex, and is sculptured radially. One specimen found in upper San Pedro series of San Pedro.

*Living.*—Lower California (Carpenter): West Coast (Keep): Halfmoon Bay (Arnold).

*Pleistocene.*—San Pedro (Arnold): San Nicolas Island (Bowers.

## Superorder STREPTONEURA.

## Order CTENOBRANCHIATA.

## Superfamily TOXOGLOSSA.

### Family L. TEREBRIDÆ.

#### Genus **Terebra** *Bruguiére.*

Shell elongated, turriculated, narrow, solid; whorls numerous, rather flattened, with superficially impressed sutures; aperture small, ovate, profoundly notched at base; columella oblique.

*Terebra nebulosa* Sowerby is a characteristic species.

##### Section *Acus (Humphrey) Gray.*

**161. Terebra (Acus) simplex** *Carpenter.*

*Myurella simplex* CPR., Brit. Assn. Rept., 1863, p. 657; Ann. & Mag. Nat. Hist., 3rd Ser., Vol. XV, 1865, p. 395. GABB, Pal. Cal., Vol. II, p. 78, 1869. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 253. KEEP, West Coast Shells, p. 56, fig, 40, 1892.
*Terebra simplex* CPR., = *T. variegata* GRAY (*fide* TRYON, Man. Conch., Vol. VII, p. 14, 1885).
*Terebra (Acus) simplex* CPR., WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 207.

Shell small, turreted, slender; apex acute; whorls ten to eleven, flat; sculpture consists of about fourteen faint, transverse ribs, each terminated on anterior end by a prominent node; a pseudo suture separates the row of nodes from the main part of the whorl; incremental lines visible; suture impressed, distinct; aperture subelliptical; outer lip thin, slightly arcuate anteriorly; inner lip smooth; plication on columella; sinus short.

*Dimensions.*—Long. 33 mm.; lat. 9 mm.; body-whorl 13 mm.; aperture 9 mm.; defl. 18 degrees.

Sculpture in this species is quite variable; some specimens have the row of nodes prominently elevated, others show only a little constriction at upper third of transverse ridge.

Common in upper, rare in lower San Pedro series of the San Pedro region. Rare in the Pliocene of Deadman Island and Timm's Point. Found in the Pleistocene at Barlow's ranch, Ventura, and at Twenty-sixth Street, Spanish Bight, and Pacific Beach, San Diego.

*Living.*—Santa Barbara to San Diego (Cooper).

*Pleistocene.*—Santa Barbara to San Diego (Cooper): San Pedro; San Diego; Ventura (Arnold).

*Pliocene.*—San Diego well (Dall): San Pedro (Arnold).

## Family LI. CONIDÆ.

### Genus **Conus** *Linné.*

Shell thick, obconic, whorls enrolled upon themselves, the spire short, or not elevated, smooth or tuberculated; aperture long, narrow, the margins parallel, truncated at the base; the outer lip with a slight sutural sinus.

*Conus marmoreus* Linn. is a characteristic species.

#### 162. **Conus californicus** *Hinds.*

*Conus californicus* Hds., Proc. Zool. Soc., 1844; Voy. Sulphur, p. 7, Pl. I, figs. 3, 4, 5, 1844. =*C. ravus* Gld. (*fide* Cpr., Brit. Assn. Rept., 1863, p. 658). Gabb, Pal. Cal., Vol. II, p. 78, 1869. Tryon, Man. Conch., Vol. VI, p 17, Pl. IV, figs. 62, 63, 1884. Cooper, 7th Ann. Rept. Cal. St. Min., 1888, p. 236. Keep, West Coast Shells, p. 54, 1892.

Shell double-conical; spire compact, elevated; apex subacute; whorls seven or eight, flat, smooth, except for incremental lines; suture irregular, appressed; body-whorl conical, subangular anteriorly, spirally ornamented with fine lines, which are most prominent on lower part of whorl; aperture long, narrow, slightly wider anteriorly; outer lip thin, bulging anteriorly; obsolete posterior sinus.

*Dimensions.*—Long. 34 mm.; lat. 18 mm.; body-whorl 29 mm.; aperture 27.5 mm.; defl. 83 degrees.

The specimens from the Pleistocene are generally much worn, but some of them retain the reddish brown coloration of the spiral lines and upper part of the whorls.

Not uncommon in the Pliocene at Deadman Island and Timm's Point; in the lower San Pedro series at Deadman Island and San Pedro; very common in the upper San Pedro series at Deadman Island, Crawfish George's, Los Cerritos, San Pedro, and Long Beach. Found also at Spanish Bight and Pacific Beach, San Diego.

*Living.*—Farallon Islands to San Diego; Lower California (Cooper).

*Pleistocene.*—Santa Barbara to San Diego (Cooper): San Pedro; San Diego (Arnold).

*Pliocene.*—San Fernando (Cooper): San Pedro; Stanford University (Arnold).

## Family LII. PLEUROTOMIDÆ.

### Genus **Pleurotoma** *Lamarck.*

Shell turriculated, fusiform, terminated anteriorly by a straight, more or less long canal; aperture oval; columellar lip smooth, straight or sinuous; outer lip somewhat sinuous, with a posterior sinus.

*Pleurotoma babylonia* Lam. is a characteristic species.

### 163. Pleurotoma perversa *Gabb.*

*Pleurotoma perversa* GABB, Proc. Cal. Acad. Sci., Vol. III, 1865, p. 183; Pal. Cal., Vol. II, pp. 6, 73, Pl. I, fig. 10, 1869. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 260.
*Surcula perversa*, GABB, TRYON, Man. Conch., Vol. VI, p. 239, Pl. VI, fig. 79, 1884.

Shell small, sinistral, elongate, slender; whorls eight to eleven, convex; surface smooth except for fine incremental lines which are convexly angulated posteriorly a little above middle of whorl; suture deeply impressed, distinct; aperture elongate-ovate; outer lip arcuate anteriorly; inner lip incrusted; columella smooth; posterior sinus prominent; anterior sinus long, narrow.

*Dimensions.*—Long. 42 mm.; lat. 11.5 mm.; body-whorl 21 mm.; aperture, including canal, 16 mm.; defl. 18 degrees.

Distinguishable from other members of this family by being sinistral.

Common in the Pliocene and lower San Pedro series at Deadman Island; in lower San Pedro series at San Pedro; and rare in the upper San Pedro series at Deadman Island, San Pedro, and Los Cerritos. Common in upper San Pedro series at Crawfish George's.

*Living.*—Vancouver Island to Catalina Island (Cooper).

*Pleistocene.*—Santa Barbara to San Pedro (Cooper): San Pedro (Arnold).

*Pliocene.*—San Pedro (Arnold).

### Subgenus **Borsonia** *Bellardi.*

Shell fusiform; with a plication upon the middle of the columella.

*Pleurotoma pyrenaica* Roualt is a characteristic species.

### 164. Pleurotoma (Borsonia) bartschi, sp. nov.

PLATE V, FIG. 7; PLATE IX, FIG. 1.

Shell small, fusiform, elongate; apex obtuse, mammilliform; whorls seven, angulated near middle; body-whorl less angulated than those of spire; anterior portion of whorl ornamented with about twelve oblique, transversely elongated nodes, which reach their greatest prominence on the angle of the whorl; body-whorl sometimes smooth and sometimes nodose; posterior portion of whorl flat and smooth except for incremental lines; incremental lines fine, oblique, and angulated convexly posteriorly on upper portion of whorl; suture deeply appressed, distinct; aperture elongate-elliptical; outer lip thin, arcuate anteriorly below posterior sinus; inner lip incrusted; columella nearly straight, incrusted, with one sharp plication in middle of aperture; posterior sinus shallow; anterior sinus prominent.

*Dimensions.*—Long. 19 mm.; lat. 7 mm.; body-whorl 11.5 mm.; aperture, including canal, 8.5 mm.; defl. 28 degrees.

Distinguishable from *B. dallii* and *B. hooveri* by the prominent nodes on the whorls. Looks very much like *Drillia torosa*, but is easily distinguishable by the plication on columella and more angulated body-whorls. Pronounced a new species by Dr. Dall. Specimens of *Borsonia bartschi* in the State Museum collection of fossils at Berkeley are labeled "*Drillia mœsta.*"

Rare in the Pliocene and lower San Pedro series at Deadman Island. The specimen figured on Plate IX is the type, which is from the lower San Pedro series at Deadman Island, and is now in the United States National Museum; the specimen figured on Plate V is a stumpy form, which might be called variety *curta*.

*Pleistocene.*—San Pedro (Arnold).

*Pliocene.*—San Pedro (Arnold).

### 165. Pleurotoma (Borsonia) dalli, sp. nov.

PLATE VI, FIG. 2.

Shell small, fusiform; spire elevated; apex mammilliform; whorls eight, sharply angulated a little anterior of middle; body-whorl less angulated than those of spire; posterior portion flat to slightly concave, anterior portion slightly convex; first four whorls slightly nodose on angle; ornamentation consists of fine oblique, incremental lines which are convexly angulated posteriorly just posterior to angle of whorl; suture deeply impressed, distinct; aperture elongate-elliptical; outer lip thin, arcuate anteriorly; inner lip incrusted; columella slightly recurved, with one prominent plication in middle of aperture; posterior sinus prominent; anterior sinus rather short.

*Dimensions.*—Long. 23.5 mm.; lat. 9 mm.; body-whorl 13 mm.; aperture, including canal, 10 mm.; defl. 27 degrees.

Distinguishable by mammilliform apex, small deflection, sharply angulated, smooth whorls, and plication on columella. Specimens pronounced new species by Dr. Dall.

Rare in lower San Pedro series and Pliocene at Deadman Island. The specimen figured is the type, which is from the lower San Pedro series at Deadman Island, and is now in the United States National Museum.

*Pleistocene.*—San Pedro (Arnold).

*Pliocene.*—San Pedro (Arnold).

### 166. Pleurotoma (Borsonia) hooveri, sp. nov.

PLATE X, FIG. 1.

Shell small, fusiform; apex mammilliform; whorls five or six, angulated slightly anterior to middle; body-whorl less angulated than those of spire; surface smooth, except for incremental lines, which are oblique, and angulated convexly posteriorly a little above angle of whorl; suture deeply impressed, distinct; aperture elliptical; outer lip thin, arcuate anteriorly below posterior sinus; inner lip incrusted; columella incrusted, straight, with one prominent plication in middle of aperture; posterior sinus shallow; anterior sinus short.

*Dimensions.*—Long. 13 mm.; lat. 6.5 mm.; body-whorl 8.2 mm.; aperture, including canal, 6.5 mm.; defl. 50 degrees.

Distinguishable from *B. dallii* by greatly depressed spire, fewer whorls and lack of nodes on apical whorls. Pronounced a new species by Dr. Dall.

Rare in lower San Pedro series; two found at Deadman Island. The specimen figured is the type, which is from the lower San Pedro series at Deadman Island, and is now in the United States National Museum.

*Pleistocene.*—San Pedro (Arnold).

Subgenus **Leucosyrinx** *Dall.*

### 167. Pleurotoma (Leucosyrinx) pedroana, sp. nov.

PLATE IX, FIG. 4.

Shell small, elongated; apex subacute; whorls six, sharply angulated near anterior margin; upper portion of whorls flat; ornamentation consists simply of incremental lines, which are angulated convexly posteriorly a little posterior to the angle of the whorl; lower portion of body-whorl, and sometimes the lower portion of the upper whorls, faintly spirally ribbed; deep sutural canal; aperture ovate; outer lip thin, bulging anteriorly; inner lip smooth; posterior rims shallow and wide; canal long, narrow; columella slightly recurved.

*Dimensions.*—Long. 17 mm.; lat. 6 mm.; body-whorl 10 mm.; aperture 7 mm.; defl. 22 degrees.

Distinguishable by the deep, canal-like suture and the prominence of the angulation on the lower part of the whorls. Specimens identified by Dr. Dall as being new.

Rare in lower San Pedro series at Deadman Island; three specimens found. The specimen figured is the type, which is from the lower San Pedro series at Deadman Island, and is now in the United States National Museum.

*Pleistocene.*—San Pedro (Arnold).

Subgenus **Genota** *Adams.*

Section *Dolichotoma Bellardi.*

Shell mitræform; whorls finely cancellated; aperture elongated, canal short; sinus profound.

*Pleurotoma mitræformis* Kiener is a characteristic species.

### 168. Pleurotoma (Dolichotoma) carpenteriana *Gabb.*

*Pleurotoma (Surcula) carpenteriana* GABB, Proc. Cal. Acad, Sci., Vol. III, 1865, p. 183; Pal. Cal., Vol. II, pp. 5, 72, Pl. I, fig. 8, 1869.

*Surcula carpenteriana* GABB, TRYON, Man. Conch., Vol. VI, p. 239, Pl VII, fig. 3, 1884. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 266. KEEP, West Coast Shells, p. 57, fig. 41, 1892.

*Genota carpenteriana* GABB, DALL, Proc. U. S. Nat. Mus., Vol. XII, 1889, p. 303.

*Pleurotoma (Dolichotoma) carpenteriana* CPR., WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 207.

Shell large, fusiform; spire elevated and about as long as the aperture; whorls eight, subflattened on the sides, slightly concave near suture, and very slightly convex anteriorly; surface ornamented with fine spiral ridges, which alternate in size on lower part of body-whorl; suture impressed; aperture narrow, widest in middle; outer lip thin, arcuate anteriorly below the wide, shallow sinus; inner lip smooth, incrusted; canal broad and short.

*Dimensions.*—Long. 88 mm.; lat. 33 mm.; body-whorl 66 mm.; aperture, including canal, 50 mm.; defl. 38 degrees.

The specimen described is an exceedingly fine specimen, a little above the average in size. Mrs. Oldroyd has over a dozen fine specimens of the living shells of this species, which have been hauled up in the fishermen's nets at San Pedro.

Not uncommon in the upper San Pedro series at San Pedro, Deadman Island, and Crawfish George's. Found also in the Pleistocene at Pacific Beach, San Diego, and at the old irrigating ditch, Ventura.

*Living.*—Monterey to San Diego (Cooper): Cerros Island (Dall).

*Pleistocene.*—Santa Barbara; San Pedro (Cooper): San Pedro; San Diego; Ventura (Arnold).

*Pliocene.*—Santa Rosa; San Fernando (Cooper): San Diego well (Dall).

### 169. Pleurotoma (Dolichotoma) cooperi, sp. nov.

PLATE VII, FIG. 3.

Shell large, fusiform; spire elevated, same length as aperture; whorls seven, prominently angulated near middle; upper portion decidedly concave, lower portion slightly convex; first five whorls slightly nodose on angle, rest of whorls smooth on angle, except for roughness caused by incremental lines; surface ornamented with revolving spiral ridges, most prominent on the lower portion of whorls, and with prominent incremental lines, which, following the outline of the lip, are convexly angulated posteriorly on the upper portion of the whorl and concavely angulated on the lower portion; on the upper whorls the nearly equal prominence of the two systems of sculpture give the shell a cancellated appearance; aperture long, narrow, with sides nearly parallel; outer lip thin, arcuate anteriorly below sinus; inner lip smooth, incrusted; posterior sinus shallow, broad; canal short, nearly as wide as aperture.

*Dimensions.*—Long. 65 mm.; lat. 24 mm.; body-whorl 42.5 mm.; aperture, including canal, 33 mm.; defl. 39 degrees.

Distinguishable by the decided convexity of the upper portion of the whorl, smooth angle and cancellated appearance of upper whorls.

Rare in upper San Pedro series of San Pedro; one specimen found. The specimen figured is the type, which is from the upper San Pedro series at San Pedro, and is now in the United States National Museum.

*Pleistocene.*—San Pedro (Arnold).

### 170. Pleurotoma (Dolichotoma) tryoniana *Gabb.*

*Pleurotoma (Surcula) tryoniana* GABB, Pal. Cal., Vol. II, p. 6, Pl. I, fig. 9, 1869.
*Surcula tryoniana* GABB, COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 266.

Shell resembles *P. carpenteriana* in shape; whorls eight, convex anterior to middle, with row of nodes on angle; upper portion of whorls concave; surface ornamented with revolving ridges, rather coarser on lower portion of whorl; suture impressed; aperture elongate, narrow, widest in middle; outer lip thin, bulging below the wide, shallow sinus; inner lip smooth; canal short, broad.

*Dimensions.*—Long. 75 mm.; lat. 28 mm.; body-whorl 52 mm.; aperture, including canal, 40 mm.; defl. 33 degrees.

Distinguishable by nodose, convex, angular whorls.

Rare in upper San Pedro series of San Pedro. Mrs. Oldroyd has several specimens of this species, which have been hauled up alive in the fishermen's nets at San Pedro.

*Living.*—San Diego (Cooper): San Pedro (Oldroyd).

*Pleistocene.*—Santa Barbara; San Pedro (Cooper): San Pedro (Arnold).

## Genus **Drillia** *Gray.*

Shell turriculated; aperture oval, oblique; canal short, twisted; columella lip strongly callous above.

*Pleurotoma gibbosa* Kiener is a characteristic species.

### 171. **Drillia cancellata** *Carpenter.*

*Drillia cancellata* CPR., Brit. Assn. Rept., 1863, p. 658; Proc. Phil. Acad. Nat. Sci., 1865, p. 63. TRYON, Man. Conch., Vol. VI, p. 183, 1884.

Shell resembles *D. inermis* in shape; whorls eight or nine, nearly flat, but slightly angulated near anterior margin; decoration consists of five to six spiral ridges and about twenty-five rather more prominent transverse, slightly oblique ribs, the whole giving the whorls a cancellated appearance; suture impressed, distinct; canal long, prominent.

The four specimens found were young, and no adult has so far been recorded from this formation.

Found in the lower San Pedro series of Deadman Island, and in the upper San Pedro series of Los Cerritos. Found in the Pleistocene at Spanish Bight, San Diego.

*Living.*—Puget Sound (Carpenter).

*Pleistocene.*—San Pedro; San Diego (Arnold).

### 172. **Drillia hemphilli** *Stearns.*

PLATE V, FIG. 8.

*Drillia hemphilli* STEARNS, Proc. Cal. Acad. Sci., Vol. V, 1874, p. 80, Pl. I, fig. 3. TRYON, Man. Conch., Vol. VI, p. 185, Pl. XIII, fig. 49, 1884.

Shell small, elongate, slender; apex acute; whorls eight, slightly convex, with fifteen distinct, transverse, slightly oblique, rounded ribs; flat anterior sutural riblet about one-fifth the width of whole whorl; suture impressed, distinct; spiral sculpture consists of a few faint grooves; outer lip thin, bulging anteriorly below posterior sinus, which is deep and narrow; anterior sinus short; inner lip and inner side of columella incrusted.

*Dimensions.*—Long. 16 mm.; lat. 5 mm.; body-whorl 8 mm.; aperture, including canal, 5.5 mm.; defl. 20 degrees.

The specimen described is the largest one found, the normal length being about 10 mm. Distinguishable by its small size, prominent sutural riblet, and oblique transverse ridges.

Found in lower San Pedro series of Deadman Island and San Pedro, and in the upper San Pedro series of Los Cerritos, San Pedro, and Crawfish George's. Found in the Pleistocene at Barlow's ranch, Ventura; and at Spanish Bight and Twenty-sixth Street, San Diego. The specimen figured is from the upper San Pedro series at San Pedro, and is now in the collection of Delos Arnold.

*Living.*—Lower California (Stearns).

*Pleistocene.*—San Pedro; Ventura (Arnold): San Diego (Stearns; Arnold; Hemphill).

[S. D.] **Drillia incisa** *Carpenter.*

*Drillia incisa* CPR., Brit. Assn. Rept., 1863, p. 657. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 239.

Shell like *D. inermis*, except that the spiral sculpture consists of several impressed grooves.

Found in the Pleistocene at Pacific Beach, San Diego.

*Living.*—Straits of Fuca to Santa Cruz (Cooper).

*Pleistocene.*—Santa Barbara to San Pedro (Cooper): San Diego (Arnold).

### 173. Drillia inermis *Hinds.*

PLATE V, FIG. 10.

*Pleurotoma inermis* HDS., Proc. Zool. Soc., 1843, p. 37; Voyage Sulphur, p. 16, Pl. V, fig. 8, 1844.
*Drillia inermis* HDS., CPR., Brit. Assn. Rept., 1863, p. 657. GABB, Pal. Cal., Vol. II, p. 72, 1869. TRYON, Man. Conch., Vol. VI, p. 182, Pl. XII, figs. 40 and 43; Pl. XXXII, fig. 42, 1884. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 239.

Shell elongate, slender; spire elevated; apex acute; whorls eight or nine, slightly angulated a little posterior to middle, the posterior portion being slightly concave, and the anterior portion slightly convex; ornamentation consists of nine to eleven rounded, spiral ridges, and numerous prominent transverse ridges following the lines of growth, which are convexly angulated on the angle of whorl; the ornamentation is more prominent on the lower portion of the whorls; suture impressed, distinct; aperture elliptical; outer lip thin, arcuate anteriorly; posterior sinus shallow; anterior sinus rather long; inner lip and inner portion of columella incrusted; columella slightly recurved.

*Dimensions.*—Long. 30 mm.; alt. 9 mm.; body-whorl 17 mm.; aperture, including canal, 11.5 mm.; defl. 22 degrees.

Distinguishable from *D. penicillata* by longer canal, angulation of whorls, and greater prominence of ornamentation; distinguishable from *D. cancellata* by less deflection and angulation of whorl, except body-whorl, which is more evenly convex than in the latter.

Rare in lower San Pedro series of Deadman Island, and in the upper San Pedro series of Los Cerritos and San Pedro. The specimen figured is from the upper San Pedro series at San Pedro, and is now in the collection of Delos Arnold. Found in the Pleistocene at Barlow's ranch, and the old irrigating ditch, Ventura; and at Spanish Bight and Pacific Beach, San Diego.

*Living.*—Santa Barbara to San Diego; Lower California (Cooper).

*Pleistocene.*—Santa Barbara (Cooper): San Pedro; San Diego; Ventura (Arnold).

### 174. Drillia inermis var. penicillata *Carpenter.*

*Drillia penicillata* CPR., Brit. Assn. Rept., 1863, p. 658; Jour. de Conch., Vol. XIII, 1865, p. 146. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 239. KEEP, West Coast Shells, p. 56, fig. 38, 1892. WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 208.
*Pleurotoma penicillata* CPR., TRYON, Man. Conch., Vol. VI, p. 182, Pl. XII, fig. 40, 1884.

Shell elongated; spire elevated; apex acute; whorls eight, only slightly convex; ornamented with numerous nearly obsolete, rounded, spiral ridges, and fine incremental lines which, reproducing

the outline of the lip and posterior sinus, form in the middle of the whorl an angle open anteriorly; transverse ornamentation more prominent on apical whorls; suture impressed, distinct; aperture elliptical; outer lip thin, arcuate anteriorly; posterior sinus shallow, wide; anterior sinus short; columella slightly curved to left; spirally ridged.

*Dimensions.*—Long. 26.5 mm.; lat. 9 mm.; body-whorl 14.5 mm.; aperture including canal, 11 mm.; defl. 22 degrees.

Distinguishable by the beautiful wavy incremental lines, which are quite prominent in most specimens. Some of the shells reach a length of 40 mm. Grades imperceptibly into *D. inermis*.

Not uncommon in the lower San Pedro series at Deadman Island and San Pedro, and in the upper San Pedro series at Deadman Island, San Pedro, Los Cerritos, Long Beach, and Crawfish George's. Found in the Pleistocene at Spanish Bight and Pacific Beach, San Diego; and at the old irrigating ditch and Barlow's ranch, Ventura.

*Living.*—San Pedro, south; Cerros Island; Lower California (Cooper).

*Pleistocene.*—San Pedro to San Diego (Cooper): San Pedro (Arnold).

### 175. **Drillia johnsoni**, sp. nov.

PLATE VIII, FIG. 17.

Shell of medium size, turreted; whorls eight or nine, nearly flat, each crossed by about thirteen prominent, rounded, equal, equidistant, oblique ribs, which begin at anterior portion of whorl and extend for about two-thirds distance across whorl, where they become nearly obsolete; a sutural band occupies the upper third of the whorl; lower portion of whorl with five deep, channel-like sulcations; sutural band with strong, oblique incremental lines; suture appressed, undulating; aperture subelliptical; outer lip arcuate; posterior sinus narrow, rather deep; anterior sinus short, recurved; columella incrusted; body-whorl convex, extended below, with revolving sulcations on lower portion; transverse ridges obsolete on lower portion.

*Dimensions* —Alt. 32 mm.; lat. 11 mm.; body-whorl 16.8 mm.; aperture, including canal, 12 mm.; canal 2 mm.; defl. 25 degrees.

Resembles *P. montereyensis*, but is distinguishable by larger size, less prominent but more sculptured sutural band, longer and more oblique ribs, and more numerous spiral sulcations. Distinguishable from *P. aurantia* by much larger size, more prominent and more sculptured sutural band, more distinct spiral sulcations, longer and less oblique aperture, and a recurved rather than a straight anterior sinus. Pronounced a new species by Dr. Dall. Named in honor of Henry R. Johnson of Washington, D. C., who has prepared many of the drawings used in illustrating this paper.

Type specimen from upper San Pedro series of San Pedro. The specimen figured is the type, which is now in the United States National Museum. Found also in the upper San Pedro series at Deadman Island by W. B. Barber.

*Pleistocene.*—San Pedro (Arnold; Barber).

### 176. Drillia merriami, sp. nov.

PLATE VIII, FIG. 7.

Shell small, fusiform, rather thin; apex blunt; whorls seven, somewhat angular, with about fourteen slightly oblique, prominent, rather sharp transverse ridges; these ridges are most prominent on angle of whorl, and become obsolete near anterior margin and at about one-third width of whorl from posterior margin; a narrow sutural band occupies upper one third of whorl; incremental lines visible; suture deeply impressed, distinct; body-whorl somewhat ventricose and narrowed anteriorly, with transverse ribs sometimes obsolete; aperture broadly elliptical, narrowed anteriorly to a prominent sinus; posterior sinus small, near suture; outer lip arcuate, thin; columella smooth.

*Dimensions.*—Long. 14.2 mm.; lat. 5.2 mm.; body-whorl 7.6 mm.; aperture, including canal, 6 mm.; canal 1.5 mm.; defl. 31 degrees.

This species somewhat resembles *Borsonia bartschi*, but may be distinguished by lack of columellar plait, longer but less oblique transverse ridges, and narrower sutural band. Distinguishable from *D. hemphilli* by lack of spiral sulcations, less oblique ribs, much longer body-whorl, and much more prominent canal. Distinguishable from *D. torosa* by lack of spiral lines, narrower sutural band, less convex whorls, and more and longer ribs. This species is said by Dr. Dall to be near the Panama species *D. pallida* Sby. Named in honor of Dr. John C. Merriam, Professor of Paleontology in the University of California, who has assisted the writer in many ways in the preparation of this paper.

Rare in Pliocene and lower San Pedro series of Deadman Island. The specimen figured is the type, which is from the lower San Pedro series at Deadman Island, and is now in the United States National Museum.

*Pleistocene.*—San Pedro (Arnold).

*Pliocene.*—San Pedro (Arnold).

### 177. Drillia montereyensis *Stearns.*

*Pleurotoma (Drillia) montereyensis* STEARNS, Proc. Cal. Acad. Sci., Vol. V, 1873, p. 80, Pl. I, fig. 21. TRYON, Man. Conch., Vol. VI, p. 184, Pl. XII, fig. 30, 1884.

Shell small, elongate, slender; seven moderately rounded whorls, upper portion of volutions concavely angulated and ornamented with fine spiral ribs and furrows; middle of upper whorls and upper part of body-whorl displaying fifteen equidistant, longitudinal, nodose, slightly oblique ribs; on the smaller volutions of the spire a puckering at and following the suture suggests a second indistinct series of nodules; aperture less than half the length of shell; canal short; posterior sinus rather broad, rounded and of moderate depth.

*Dimensions.*—Long. 15 mm.; lat. 6 mm.; body-whorl 8.4 mm.; aperture 6 mm.; defl. 22 degrees.

Resembles a large *D. hemphilli* in shape, but has a very distinctive ornamentation.

Rare in the lower San Pedro series at Deadman Island; of the two specimens found, one was obtained by Mrs. Oldroyd.

*Living.*—Monterey (Stearns).

*Pleistocene.*—San Pedro (Oldroyd; Arnold).

### 178. Drillia pudica *Hinds.*

PLATE VIII, FIG. 13.

*Pleurotoma pudica* HDS., Proc. Zool. Soc., 1843, p. 41; Voyage Sulphur, p. 20, Pl. VI, fig. 11, 1844. CPR., Brit. Assn. Rept., 1856, p. 330. TRYON, Man. Conch., Vol. VI, p. 189, Pl. XIII, fig. 55, 1884.

Shell small, resembling *D. torosa* in general appearance; whorls seven, angular, convex below, concave above, with twelve or thirteen transverse ribs, nearly all of which extend from suture to suture, but less prominent on the concave surface; surface spirally sulcate; in other respects similar to *torosa*.

*Dimensions.*—Long. 11 mm.; lat. 4 mm.; defl. 25 degrees.

Distinguishable from *D. torosa* by the long transverse ribs, and by the more convex outline of the whole shell. Specimen identified by Dr. Dall.

Rare; one specimen from upper San Pedro series of San Pedro, which is figured, and is now in the collection of Delos Arnold.

*Living.*—Central America (Carpenter).

*Pleistocene.*—San Pedro (Arnold).

### 179. Drillia renaudi, sp. nov.

PLATE VIII, FIG. 5.

Shell small, fusiform, turreted; apex blunt; whorls eight, sharply angular, with angle about two-fifths distance from anterior margin of whorl; upper and lower surfaces flat; about fifteen oblique nodes ornament the angle and extend down on the lower portion of the whorl, becoming obsolete before reaching the suture; nodes obsolete on body-whorl; suture deeply impressed, distinct; aperture short, elliptical, oblique; posterior sinus broad, shallow; anterior sinus long, straight; columella incrusted within; body-whorl angular, ventricose, much produced and narrow below, smooth, except for very faint incremental lines.

*Dimensions.*—Long. 15.8 mm.; lat. 6 mm.; body-whorl 9 mm.; aperture, including canal, 7 mm.; canal 2 mm.; defl. 35 degrees.

Different in shape from any other member of this genus found in these deposits. Distinguishable by the smooth, ventricose body-whorl, sharply angulated whorls, nodose angle, and long canal. This species has the long canal of *D. perversa*, the angular whorls of *Leucosyrinx pedroana*, and the nodes, though less prominent, of *D. torosa*. Specimens pronounced a new species by Dr. Dall. Named in honor of Ralph E. Renaud, who has prepared many of the drawings which illustrate this paper.

Rare; one specimen from Pliocene and one (type) from lower San Pedro series of Deadman Island. The specimen figured is the type, which is now in the United States National Museum.

*Pleistocene.*—San Pedro (Arnold).

*Pliocene.*—San Pedro (Arnold).

### 180. Drillia torosa *Carpenter.*

*Drillia torosa* CPR., Brit. Assn. Rept., 1863, p. 657; Jour. de Conch., 3rd Ser., Vol. XV, 1865, p. 145. TRYON, Man. Conch., Vol. VI, p. 183, Pl. XIV, fig. 93, 1884. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 239. KEEP, West Coast Shells, p. 56, fig. 59, 1892. WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 298.

Shell elongated; spire elevated; apex acute; whorls eight, angulated near middle, with row of about nine nodes, transversely elongated, on angle; the upper portion of whorl flat to concave; anterior half of whorl spirally striated; incremental lines visible, oblique, and on upper part of whorl, concave anteriorly; suture impressed, distinct; lower portion of body-whorl and columella spirally striated; aperture elliptical; outer lip thin and arcuate anteriorly; inner lip and columella slightly incrusted; posterior sinus shallow; anterior sinus short, straight.

*Dimensions.*—Long. 25 mm.; lat. 8 mm.; body-whorl 14.5 mm.; aperture, including canal 9.5 mm.; defl. 22 degrees.

Distinguishable by the nodose whorls. The relative length of canal varies somewhat in this species, as does also the prominence of the nodes.

Found in the Pliocene at Deadman Island and Timm's Point; in the lower San Pedro series at Deadman Island and San Pedro; and in the upper San Pedro series at Deadman Island, San Pedro, Los Cerritos, and Crawfish George's. Most common in the lower formations.

*Living.*—Santa Cruz to Santa Barbara (Cooper): San Pedro (Williamson).

*Pleistocene.*—Santa Barbara (Cooper): San Pedro (Arnold).

*Pliocene.*—San Pedro (Arnold).

## Genus **Bela** *Gray.*

Shell oval, fusiform, thin; spire produced; canal short; sinus small, near the suture; columella flattened; operculum pointed at both ends.

*Pleurotoma turricula* Montf. is a characteristic species.

### 181. Bela fidicula *Gould.*

PLATE VII, FIG. 10.

*Fusus fidicula* GLD., Proc. Bost. Soc. Nat. Hist., Vol. III, 1849, p. 142; Wilkes' Expl. Exped., Vol. XII, p. 233, fig. 284, 1852.

*Bela fidicula* GLD., CPR., Brit. Assn. Rept., 1863, p. 658. TRYON, Man. Conch., Vol. VI, p. 222, Pl. XXXII, fig. 17, 1884.

Shell small, thin, turreted, short, fusiform; whorls seven, angular, forming a broad shoulder at the suture; surface sculptured with delicate, regular, obtuse, transverse rib-folds, about twenty-four on the last whorl, on the middle of which they disappear, decussated by more crowded, delicate grooves, a little undulating, about eight on the penultimate whorl; suture deeply impressed, distinct; aperture narrow, elliptical; outer lip thin, slightly arcuate; pillar smooth interiorly, spirally striate externally; canal short.

*Dimensions.*—Long. 10 mm.; lat. 4.1 mm.; body-whorl 6.8 mm.; aperture 5 mm.; defl. 30 degrees.

Found in Pliocene at Deadman Island, lower San Pedro series at Deadman Island, and upper San Pedro series at Crawfish George's. Found also in the Pleistocene

in bluff west of bath-house, Santa Barbara, and at old irrigating ditch, Ventura. The specimen figured is from the lower San Pedro series at Deadman Island, and is now in the collection of Delos Arnold.

*Living.*—Puget Sound (Carpenter).

*Pleistocene.*—San Pedro; Santa Barbara; Ventura (Arnold).

*Pliocene.*—San Pedro (Arnold).

### 182. **Bela sanctæ-monicæ**, sp. nov.

PLATE VIII, FIG. 14.

Shell small, broadly fusiform; spire elevated; apex subacute; whorls five, convex, slightly angular above, with about sixteen prominent, rounded ribs, which extend from suture to suture; surface sculptured with spiral sulcations; suture deeply impressed, distinct; aperture slightly oblique, subelliptical; canal short; body-whorl ventricose, lacking transverse sculpture on lower portion; pillar smooth.

*Dimensions.*—Long. 12 mm.; lat. 7.5 mm.; body-whorl 8.5 mm.; aperture, including canal, 6.8 mm.; canal 1 mm.; defl. 50 degrees.

Distinguishable from *B. fidicula* by much broader form, fewer and less sharply angular whorls, and more ventricose body-whorl, and less elevated spire. The type specimen was examined by Dr. Dall, who pronounced it a new species.

Type from lower San Pedro series (Pleistocene) at Port Los Angeles, near Santa Monica. Five specimens of the same species, with slightly more angulated whorls, were found in the lower San Pedro series of Deadman Island. The specimen figured is the type, which is now in the United States National Museum.

*Pleistocene.*—San Pedro; Port Los Angeles (Arnold).

## Genus **Mangilia** *(Leach) Risso.*

The present genus includes all *Pleurotomidæ* without opercula.

## Subgenus **Clathurella** *Carpenter.*

Shell fusiform or turriculated; columella lip without callosity, except a small posterior tooth; no operculum; the cancellated surface, more ventricose form, and more evident canal, distinguish it from *Mangilia*; the emargination of the outer lip from *Clavatula*; the texture and sculpture of the surface from *Bela* and *Daphnella.*

*Pleurotoma linearis* Blainv. is a characteristic species.

### 183. **Mangilia (Clathurella) conradiana** *Gabb.*

*Clathurella conradiana* GABB, Pal. Cal., Vol. II, p. 7, Pl. I, fig. 12, 1869. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 235.

Shell small, robust, broadly fusiform; spire high, whorls seven, the first smooth and round, the remainder angulated, concave above, convex below; surface ornamented by ten or twelve rounded transverse ribs, crossed by square elevated ribs, with sometimes smaller ones interposed; on the upper

or concave part of whorl are several fine, revolving lines; suture deeply impressed, distinct; aperture long, narrow; posterior sinus near suture deep, prominent; anterior sinus short, recurved; outer lip arcuate; pillar straight, spirally striate.

*Dimensions.*—Long. 11.5 mm.; lat. 4.5 mm.; body-whorl 6.9 mm.; aperture 5.5 mm.; defl. 35 degrees.

Distinguishable by deep posterior sinus from other members of the same family. (Originally described from Pleistocene specimen.) Pronounced as "near *C. canfieldii* Dall," by Dr. Dall.

Rather common in the Pliocene and lower San Pedro series of Deadman Island; rare in the lower San Pedro series and upper San Pedro series of San Pedro. Found in the Pliocene at Packard's Hill; and in the Pleistocene at the bath-house, Santa Barbara.

*Living.*—San Pedro (Raymond).

*Pleistocene.*—Santa Barbara (Cooper): San Pedro; Santa Barbara (Arnold).

*Pliocene.*—San Pedro; Santa Barbara (Arnold): San Diego well (Dall).

### Subgenus **Cythara** *Schumacher.*

Shell fusiform, polished, longitudinally ribbed; aperture linear, truncated in front, slightly notched behind; outer lip margined, denticulated within; inner lip frequently finely striated.

*Pleurotoma stromboides* Reeve is a characteristic species.

### 184. **Mangilia (Cythara) branneri,** sp. nov.

PLATE IX, FIG. 10.

Shell small, fusiform; spire elevated; apex rounded; whorls six; slightly convex, with six sharp, slightly oblique, transverse ribs arranged in slightly twisted lines radiating from the apex; suture impressed, distinct; aperture narrow, truncated in front, slightly notched behind; outer lip margined; inner lip smooth.

*Dimensions.*—Long. 10 mm.; lat. 4 mm.; body-whorl 6 mm.; aperture 4.5 mm.; defl. 27 degrees.

Distinguishable by the few longitudinally connected, sharp, radiating ridges. Pronounced by Dr. Dall as probably being new. Named in honor of Dr. John C. Branner, Professor of Geology in Leland Stanford Jr. University.

Rather common in lower San Pedro series of Deadman Island. Found also in the Pleistocene at bath-house, Santa Barbara. The specimen figured is the type, which is from the lower San Pedro series at Deadman Island, and is now in the United States National Museum.

*Pleistocene.*—San Pedro; Santa Barbara (Arnold).

### Subgenus **Mangilia** *Risso, s. s.*

Fusiform, mostly longitudinally ribbed, spire elongated, turriculated, acuminated; canal short, more or less truncated; columella smooth; sinus near the suture. No operculum.

*Pleurotoma ponderosa* Reeve is a characteristic species.

### 185. Mangilia angulata *Carpenter.*

PLATE VII, FIG. 9.

*Mangilia angulata* CPR., Brit. Assn. Rept., 1863, p. 658; Ann. & Mag. Nat. Hist., 3rd Ser., Vol. XV, 1865, p. 395. KEEP, West Coast Shells, p. 55, 1892. COOPER, Bull. No. 4, Cal. St. Min. Bureau, 1894, Part 3, p. 27.

Shell small, turreted, elongate-fusiform; apex acute; whorls six, broad and angular, angle being slightly posterior to middle; sculpture consists of ten prominent, rather sharp, transverse ridges which reach maximum prominence on angle of whorl; suture deeply impressed, distinct, aperture oblique, narrow, elliptical, drawn out anteriorly into a short, narrow canal; outer lip thin; simple, arcuate; inner lip smooth.

*Dimensions.*—Long. 8 mm.; lat. 3.2 mm.; body-whorl 5 mm.; aperture 4 mm.; defl. 33 degrees.

Some of the shells show a very faint spiral sculpture. Distinguishable by broad form and simple transverse sculpture. Specimens identified by Dr. Dall.

Many specimens of this species in the State museum collection of fossils at Berkeley are labeled "*M. variegata.*"

Rather common in the lower San Pedro series of Deadman Island and San Pedro; rare in the upper San Pedro series at Crawfish George's and Los Cerritos. Found also in the Pleistocene at bath-house, Santa Barbara; Barlow's ranch, Ventura, and at Spanish Bight and Pacific Beach, San Diego. The specimen figured is from the lower San Pedro series at Deadman Island, and is now in the collection of Delos Arnold.

*Living.*—Puget Sound to Santa Barbara (Carpenter).

*Pleistocene.*—San Pedro (Arnold): San Joaquin Bay, Orange County (Bowers): Santa Barbara; Ventura; San Diego (Arnold).

### 186. Mangilia hooveri, sp. nov.

PLATE IX, FIG. 5.

Shell small, elongate-fusiform, solid; spire elevated; apex mammilliform; whorls six, only slightly convex, with about ten low, rounded, slightly oblique, transverse ridges; the first whorl is smooth, while the next three are more convex than the lower ones, and have traces of spiral sculpture; body-whorl with sculpture nearly obsolete; aperture elliptical, tapering to a very short canal anteriorly; outer lip arcuate, thin; pillar quite long and straight.

*Dimensions.*—Long. 10.9 mm.; lat. 3 mm.; body-whorl 6 mm.; aperture 4 mm.; defl. 20 degrees.

Distinguishable by the slender form, nearly flat whorls, and the broad, low, transverse ridges. The body-whorl resembles that of a small, elongate-pillared *Drillia.* Pronounced new by Dr. Dall. Named in honor of Mr. T. J. Hoover of Stanford University, California.

Type from upper San Pedro series of San Pedro; rare. The specimen figured is the type, and is now in the United States National Museum.

*Pleistocene.*—San Pedro (Arnold).

### 187. Mangilia interfossa var. pedroana, var. nov.

PLATE VI, FIG. 3.

*Mangilia interfossa* CPR., Brit. Assn. Rept., 1863, p. 658; Ann. & Mag. Nat. Hist., 3d Ser., Vol. XV., 1865, p. 29.

*Daphnella interfossa* CPR., TRYON, Man. Conch., Vol. VI, p. 310, Pl. XXII, fig. 11, 1884.

Shell small, turreted, elongate-fusiform; apex acuminate; whorls six, convex, ornamented with about sixteen rounded, slightly oblique, transverse ridges and four to six sharp, raised, spiral lines in the interspaces; suture deeply impressed; aperture narrow, slightly oblique, elliptical; outer lip thin, simple; inner lip smooth.

*Dimensions.*—Long. 7.5 mm.; lat. 2.5 mm.; body-whorl 4.1 mm.; aperture 2.8 mm.; defl. 30 degrees.

Distinguishable from *M. interlirata* by broader form, more convex whorls, and more numerous lines of sculpture. Specimens pronounced new variety of *M. interfossa* by Dr. Dall.

Rare in lower San Pedro series at Deadman Island; and in upper San Pedro series at Crawfish George's. Found also in the Pleistocene at bath-house, Santa Barbara. The specimen figured is the type, which is from the lower San Pedro series at Deadman Island, and is now in the United States National Museum.

*Pleistocene.*—San Pedro; Santa Barbara (Arnold).

### 188. Mangilia interlirata *Stearns.*

PLATE VI, FIG. 15.

*Mangilia interlirata* STEARNS, Proc. Cal. Acad. Sci., Vol. IV, 1872, p. 226, Pl. I, fig. 10. TRYON, Man. Conch., Vol. VI, p. 249, Pl. XXII, fig. 56, 1884.

Shell small, elongate, fusiform; spire much elevated; apex acute; whorls six, slightly convex, ornamented by nine or ten slightly oblique, rather narrow, transverse ridges; spiral sculpture consists of three or four sharp raised lines, which extend to base of body-whorl; suture impressed, distinct; aperture narrow, elliptical; outer lip thin, simple; inner lip simple; canal simple.

*Dimensions.*—Long. 8.8 mm.; lat. 3 mm.; body-whorl, 4.9 mm.; aperture, 3 mm.; defl. 25 degrees.

Distinguishable from *M. interfossa* var. *pedroana* by its slenderer outline, fewer transverse and spiral ridges, and flatter whorls; distinguished from others of the genus by the prominence of its spiral lines. Specimens identified by Dr. Dall.

Rare in lower San Pedro series at Deadman Island, and in the upper San Pedro series at Los Cerritos. The specimen figured is from the Lower San Pedro series at Deadman Island, and is now in the collection of Delos Arnold.

*Living.*—West Coast.

*Pleistocene.*—San Pedro (Arnold).

### 189. Mangilia oldroydi, sp. nov.

PLATE VI, FIG. 16.

Shell small, turreted, elongate-fusiform; apex acuminate; whorls seven, convex, rather shouldered above, and crossed by sixteen slightly oblique rounded ridges; transverse ridges become

obsolete on lower half of body-whorl; spiral sculpture consists of three or four fine raised lines on lower portion of whorl and several microscopic lines on upper portion; the spiral sculpture is more prominent on the body-whorl; suture deeply impressed; aperture narrow pyriform, drawn out on anterior end to a long, narrow, recurved canal; outer lip arcuate, thin, simple; inner lip smooth.

*Dimensions.*—Long. 16 mm.; lat. 6 mm.; body-whorl 10 mm.; aperture 8 mm.; defl. 38 degrees.

The largest and finest of the Pleistocene *Mangiliæ*. Distinguishable by its large size, rounded ridges, faint shouldered appearance of the whorls, and long, recurved canal. "Different from any of the species in the Smithsonian collection" (Dall).

Rare in lower San Pedro series of Deadman Island; one specimen (type) collected by Mrs. Oldroyd, which is figured, and is now in her collection.

*Pleistocene.*—San Pedro (Oldroyd).

### 190. Mangilia painei, sp. nov.

PLATE VIII, FIG. 1.

Shell small, elongate-fusiform; spire elevated; apex rounded; whorls seven, evenly convex, with about eleven slightly transverse, rounded ribs, which become obsolete at the sutures; spiral sculpture obsolete; aperture narrow, elliptical, narrowing anteriorly to canal; canal truncate in front; posterior sinus small; outer lip arcuate, thin, with faint ridge on interior; suture deeply impressed; pillar long, smooth within, obsolete sculpture without.

*Dimensions.*—Long. 12 mm.; lat. 4.2 mm.; body-whorl 8 mm.; aperture, including canal, 6.1 mm.; canal 1.5 mm.; defl. 32 degrees.

Distinguishable by slender form, evenly convex whorls, prominent transverse ribs, and obsolete spiral sculpture; canal also longer than in most species. Resembles *M. oldroydi* in outline, but has no spiral sculpture or angulated whorls. Pronounced a new species by Dr. Dall. Named in honor of Miss Winifred Mabel Paine of Redlands, California, who has drawn many of the figures illustrating this paper.

Not uncommon in the lower San Pedro series of Deadman Island. The specimen figured is the type, which is from the lower San Pedro series of Deadman Island, and is now in the United States National Museum.

*Pleistocene.*—San Pedro (Arnold).

### 191. Mangilia sculpturata *Dall.*

PLATE VI, FIG. 17.

*Bela sculpturata* DALL, Proc. U. S. Nat. Mus., Vol. IX, 1887, p. 299, Pl. IV, fig. 7.

Shell small, turreted, elongate-fusiform; apex acute; whorls seven, sharply angulated, with flat, sloping surfaces both above and below angle; sculpture consists of eight or nine sharp transverse ridges, and two or three sharp spiral lines on lower portion; aperture very deeply impressed, giving tabulate appearance to whorls; aperture long, narrow, and drawn out into a long, narrow canal at anterior end; outer lip thin, simple; inner lip smooth; spiral sculpture extends to base of pillar.

*Dimensions.*—Long. 10.5 mm.; lat. 3 mm.; body-whorl 6 mm.; aperture 4 mm.; defl. 23 degrees.

A slender, deeply sutured form, with a comparatively long canal; these characteristics distinguishing it from others of the genus. Specimen identified by Dr. Dall.

Rare in Pliocene and lower San Pedro series of Deadman Island; one specimen from each horizon. The specimen figured is from the Pliocene of Deadman Island, and is now in the collection of Delos Arnold.

*Living.*—West Coast.

*Pleistocene.*—San Pedro (Arnold).

*Pliocene.*—San Pedro (Arnold).

### 192. Mangilia striosa *C. B. Adams.*

PLATE IX, FIG. 3.

*Mangilia striosa* C. B. ADS., Ann. N. Y. Lyc. Nat. Hist., Vol. V, 1852, p. 147. TRYON, Man. Conch., Vol. VI, p. 249, Pl. XXXIV, fig. 96, 1884. WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, p. 208, 1892.

Shell small, elongate-fusiform; spire much elevated; apex acute; whorls six, subangular, with numerous fine, slightly wavy transverse ridges, which become obsolete at the sutures; spiral sculpture nearly obsolete; suture very deeply depressed, giving a rather frail appearance to the spires; aperture narrow, elliptical, tapering anteriorly to a short, truncated canal; posterior sinus small; outer lip thin, simple, arcuate; columella smooth; straight on anterior portion.

*Dimensions.*—Long. 9.2 mm.; lat. 3 mm.; body-whorl 5.2 mm.; aperture 4 mm.; defl. 22 degrees.

This species is distinguishable by its numerous fine, transverse ridges, deep suture, subangular whorls, and slender form. Resembles *M. sculpturata* somewhat in outline, but has less angular whorls and more numerous, finer ribs. Distinguishable from *M. oldroydi* by the angle being nearer the middle of the whorl, the ridges being finer, the pillar shorter, and the suture deeper. Specimens identified by Dr. Dall.

Rare in upper San Pedro series of San Pedro and Los Cerritos. Found also in Pleistocene at Spanish Bight, San Diego. The specimen figured is from the upper San Pedro series at Los Cerritos, and is now in the collection of Delos Arnold.

*Living.*—Panama (Carpenter): San Pedro (Williamson).

*Pleistocene.*—San Pedro; San Diego (Arnold).

### Subgenus Taranis *Jeffreys.*

Shell minute, cancellated; whorls angulated, slightly exserted at base; aperture pyriform; outer lip thin, simple; sinus obsolete; canal short.

*Taranis morchii* Malm. is a characteristic species.

### 193. Mangilia (Taranis) strongi, sp. nov.

PLATE IX, FIG. 7.

Shell small, elongated; spire elevated; apex mammilliform; whorls six, angulated near middle, upper surface concave, lower surface convex; two strong spiral ridges, one on angle, the

other in middle of lower portion of whorl; incremental lines visible; suture impressed, distinct; aperture subovate, oblique; outer lip thin, slightly arcuate anteriorly; inner lip smooth; posterior sinus broad, very shallow; anterior sinus short; columella short, distinct.

*Dimensions.*—Long. 12 mm.; lat. 5.5 mm.; body-whorl 7 mm.; aperture 5 mm.; defl. 38 degrees.

Distinguishable from others of the same family by the two strong, revolving ridges. Named in honor of A. M. Strong. Specimens pronounced new species by Dr. Dall.

Rare in the lower San Pedro series of San Pedro and Deadman Island; found also in the Pliocene of Deadman Island, and in the upper San Pedro series at Crawfish George's. The specimen figured is the type, which is from the lower San Pedro series at Deadman Island, and is now in the United States National Museum.

*Pleistocene.*—San Pedro (Arnold).

*Pliocene.*—Santa Monica; San Pedro (Arnold).

### Subgenus **Spirotropsis** *Sars.*

Shell elongate, turreted, spire produced; the obtuse apex mammilliform; whorls numerous, carinated in the middle; aperture narrow, oblique, with a short canal; sinus deep; remote from suture.

*Pleurotoma carinata* Phil. is a characteristic species.

### 194. **Pleurotoma (Spirotropsis) smithi,** sp. nov.

PLATE VI, FIG. 13.

Shell elongate, turreted, slender; spire elevated; apex obtuse, mammilliform; whorls ten, convex, with a slight tendency toward angulation on the lower third of the whorl, and abruptly terminated at the posterior margin; suture very deeply impressed, distinct; sculpture consists simply of oblique, incremental lines, which are quite deeply angulated convexly, posteriorly just a little above the middle of the whorl; aperture narrow, oblique; outer lip thin, arcuate anteriorly; inner lip smooth and incrusted; posterior sinus deep and remote from suture; canal narrow, slightly recurved, over one-third of the aperture.

*Dimensions.*—Long. 35 mm.; lat. 11 mm.; body-whorl 8.5 mm.; aperture 13 mm.; defl. 19 degrees.

A long, slender species, slightly resembling the sinistral *P. perversa* in general outline, but easily distinguishable from that species and also from all the other members of this family. Some of the shells are a little more depressed than the type. Specimens identified by Dr. Dall as being a new species.

Not uncommon in the lower San Pedro series and Pliocene of Deadman Island. The specimen figured is the type, which is from the Pliocene of Deadman Island, and is now in the United States National Museum.

*Living.*—(Locality not mentioned) (Dall).

*Pleistocene.*—San Pedro (Arnold).

*Pliocene.*—San Pedro (Arnold).

## Family LIII. CANCELLARIIDÆ.

### Genus **Cancellaria** *Lamarck.*

### Subgenus **Cancellaria** *s. s.*

Shell oval, cancellated; last whorl ventricose; aperture oblong, canaliculated in front; canal short, sometimes recurved; columella with several large oblique plications.

Type, *Cancellaria cancellata* Linn.

#### 195. Cancellaria cooperi *Gabb.*

PLATE VII, FIG. 8.

*Cancellaria* (*Narona*) *cooperi* GABB, Proc. Cal. Acad. Sci., Vol. III, 1865, p. 186.
*Cancellaria cooperi* GABB, TRYON, Man. Conch., Vol. VII, p. 76, Pl. IV, fig. 66, 1885. WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 211, Pl. XXII, fig. 2.

Shell fusiform; spire elevated, about one-third length of shell; apex subacute; whorls six to seven, angulated, concave above, convex below; lower portion of whorl with ten to fourteen prominent, rounded, slightly oblique ribs which end in tubercles on angle; lower part of whorl ornamented with close-set spiral ridges, alternating in prominence; ridges on upper part of whorl less prominent; body-whorl ventricose and crossed by raised incremental lines; suture appressed, wavy, distinct; aperture semielliptical; outer lip not thickened, denticulated; inner lip heavily incrusted, and with two sharp, oblique plications on lower part; columella slightly twisted, rough; canal short.

*Dimensions.*—Long. 80 mm.; lat. 35 mm.; body-whorl 56 mm.; aperture, including canal, 35.5 mm.; defl. 40 degrees.

Rare in the upper San Pedro series of San Pedro; five specimens found.

Mrs. Oldroyd has a fine living specimen of this species which was hauled up in the fishermen's nets at San Pedro. The specimen figured is from the upper San Pedro series at San Pedro, and is now in the collection of Delos Arnold.

*Living.*—Monterey to San Diego (Cooper): San Pedro (Oldroyd).

*Fleistocene.*—San Pedro (Arnold).

#### 196. Cancellaria crawfordiana *Dall.*

*Cancellaria crawfordiana* DALL, Proc. U. S. Nat. Mus., Vol. XIV, 1891, p. 182, Pl. VI, fig. 1.

Shell small, fusiform; spire elevated; whorls five or six, acutely angulated above near margin; upper portion flat, forming revolving table; lower portion evenly convex; sculpture very prominent, cancellated, consisting of about twenty-five nearly straight, equidistant, transverse ribs and about ten equidistant spiral ridges of equal prominence with the transverse ones; incremental lines visible between transverse ribs; suture impressed, very distinct; aperture semielliptical; outer lip slightly thickened and faintly denticulate; inner lip not incrusted; columella with two prominent plications on the inner side; canal short and broad.

*Dimensions.*—Long. 37 mm.; lat. 16 mm.; body-whorl 24.5 mm.; aperture, including canal, 17.5 mm.; defl. 38 degrees.

Resembles *C. cooperi* in shape, but is distinguishable by the prominent cancellated sculpture.

Rare in upper San Pedro series of San Pedro; one specimen found.

*Living.*—Drake's Bay to San Diego, 20 to 30 fathoms (Dall): San Pedro (Raymond).

*Pleistocene.*—San Pedro (Arnold).

### 197. Cancellaria tritonidea *Gabb.*

PLATE VII, FIG. 5.

*Cancellaria tritonidea* GABB, Pal. Cal., Vol. II, pp. 11, 79, Pl. II, fig. 18, 1869. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 231. DALL, Proc. U. S. Nat. Mus., Vol. XIV, 1891, p. 183.

Shell large, robust-fusiform; spire elevated, subacute; whorls six, first generally decollated, angulated; upper part of first three and one-half revolutions convex; upper part of lower whorls concave; lower part of all whorls, except body-whorl, generally covered with a lamellar incrustation; ten prominent sharp nodes on angle of whorl; whorls ornamented with numerous prominent, squarish, spiral ridges between which are less prominent raised lines; incremental lines visible, and some of them which pass through the nodes have the prominence of weak varices; suture appressed, wavy, distinct; aperture subovate; outer lip not thickened; inner lip incrusted; columella rough, twisted, widened, with two prominent plications on the inner side; canal short, wide.

*Dimensions.*—Long. 90 mm.; lat. 60 mm.; body-whorl 70 mm.; aperture, not including canal 50 mm.; defl. 75 degrees.

The shell figured and described in this paper is the largest and most nearly perfect one yet found in this locality. Gabb's type specimen was beach worn and not as well preserved as the one described above, which accounts for the lack of the sharp nodes and more rounded outline of his shell. A specimen in this collection labeled "*Cancellaria vetusta* Gabb, Pliocene, Ventura" by Dr. Bowers, is of the same species. Whether Bowers' specimen came from the Pliocene or Pleistocene is a matter of doubt.

Dr. Dall pronounced *C. tritonidea* near to *C. cassidiformis* Sowerby, and it may be one form of this latter variable species.

The young shells of this species are quite variable in regard to the prominence of the nodes, amount of angulation of the whorls, and the shape of the aperture. Any one not possessing a series showing the connection between the two extremes might think them different species. *C. vetusta* is probably a precursor of, if not identical with, *C. tritonidea.*

Rather rare in the upper San Pedro series of San Pedro. Found also in the Pleistocene at Barlow's ranch and at old irrigating ditch, Ventura. The specimen figured is from the upper San Pedro series at San Pedro, and is now in the collection of Delos Arnold.

*Pleistocene.*—Coyote Creek, Ventura County; San Pedro (Cooper): San Pedro; Ventura (Arnold).

### Genus **Admete** *Möller.*

Shell oval, thin, diaphanous, covered by a thin epidermis; spire sharp; last whorl ventricose; aperture oval, feebly channeled in front, columella arcuated, obliquely truncated, with rudimentary plications; outer lip sharp.

*Admete viridula* Fabr. is a characteristic species.

#### 198. **Admete gracilior** *Carpenter.*

PLATE VII, FIG. 4.

*Cancellaria gracilior* CPR., Pal. Cal., Vol. II, p. 50, 1869. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 23.

Shell small, ovate, thin; spire elevated, subacute; whorls six, rounded to subangular, crossed by numerous prominent, rounded ridges which reach their maximum prominence on the angle of the whorl; these ridges become nearly obsolete on the anterior part of the body-whorl; spiral sculpture consists of numerous fine ridges and furrows; suture deeply depressed, giving shouldered appearance to whorls; aperture ovate; outer lip thin, smooth; inner lip only slightly incrusted; columella obliquely truncated, and having two plications on inner side; slight umbilical slit; no canal.

*Dimensions.*—Long. 11 mm.; lat. 6.3 mm.; body-whorl 7.5 mm.; aperture 5.5 mm.; defl. 50 degrees.

A unique form, looking something like a small *Fusus robustus* with the canal gone. It is quite a variable species, one specimen showing a narrower spire and fewer, but more prominent ribs than the type, while still another showed more rounded whorls and less prominent ridges.

Found in the lower San Pedro series at Deadman Island. Also obtained from the Pleistocene at the bath-house, Santa Barbara; and at Port Los Angeles, near Santa Monica. The specimen figured is from the lower San Pedro series at Deadman Island, and is now in the United States National Museum.

*Pleistocene.*—San Pedro (Oldroyd; Arnold): Santa Barbara (Carpenter; Arnold): Santa Monica (Arnold).

## Family LIV. OLIVIDÆ.

### Genus **Olivella** *Swainson.*

Shell small, polished; spire produced, acute; suture canaliculated; aperture narrow behind; enlarged anteriorly; columella plicated in front, callous posteriorly.

*Olivella undatella* is a characteristic species.

#### 199. **Olivella biplicata** *Sowerby.*

*Olivella biplicata* SBY., Tank. Cat., App., p. 33, 1825. CPR., Brit. Assn. Rept., 1863, p. 661. H. & A. ADAMS, Gen. Rec. Moll., p. 146. GABB, Pal. Cal., Vol. II, p. 75, 1869. TRYON, Man. Conch., Vol. V, p. 87, Pl. XXXIV, fig. 58, 1883. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 255. KEEP, West Coast Shells, p. 40, fig. 20, 1892. WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 212 (and varieties).

Shell small, subcylindrical; spire only slightly elevated; apex subacute; whorls five or six, flat, smooth, except for very fine incremental lines; suture appressed, very distinct; body-whorl convex, but nearly flat near outer lip; aperture elongate-triangular; outer lip thin, nearly straight; inner lip thickly incrusted, the incrustation forming quite a ridge; columella completely incrusted around lower portion, two prominent plications.

*Dimensions.*—Long. 17.7 mm.; lat. 9.6 mm.; body-whorl 15.7.; aperture 13.1 mm.; apical angle 90 degrees.

This species differs from *O. pedroana* in size and comparative width, and from *O. intorta* in having two plaits, a greater deflection, and in being much larger.

Common in the lower and upper San Pedro series, and Pliocene of the San Pedro region. Found also in the Pleistocene at Barlow's ranch and the old irrigating ditch, Ventura; at the bath-house, Santa Barbara, and at Spanish Bight and Pacific Beach, San Diego.

*Living.*—Straits of Fuca to San Diego (Cooper).

*Pleistocene.*—Santa Barbara to San Diego (Cooper): San Pedro; Santa Barbara; Ventura; San Diego (Arnold).

*Pliocene.*—Seven Mile House; Twelve Mile House; Kirker's Pass; San Diego well (Cooper): San Pedro (Arnold).

### 200. Olivella intorta *Carpenter.*

*Olivella intorta* CPR., Proc. Zool. Soc., 1856, p. 207. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 255. KEEP, West Coast Shells, p. 42, 1892. WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 212, Pl. XIX, fig. 9.

Shell small, subovate; spire elevated, solid; whorls five, flat, smooth; suture appressed, very distinct; body-whorl ventricose, smooth; aperture long, narrow, widening anteriorly; outer lip thin; inner lip incrusted, incrustation thick, forming callus on body of middle whorl near aperture; columella with smooth incrustation over lower portion, and one prominent, sharp plait on lower side.

*Dimensions.*—Long. 11.7 mm.; lat. 6 mm.; body-whorl 9.7 mm.; aperture 7.2 mm.; defl. 60 degrees.

Distinguishable from *O. pedroana* by breadth, less elevated spire, greater deflection, and larger callus on upper part of inner lip; distinguishable from *O. biplicata* by single plait on columella, less deflection and smaller size.

Quite common in the Pliocene and Pleistocene of the San Pedro region; rare in upper San Pedro series at Los Cerritos. Found in the Pleistocene at Twenty-sixth Street and Pacific Beach, San Diego; and at Barlow's ranch and the old irrigating ditch, Ventura.

*Living.*—Santa Cruz to Lower California (Dall).

*Pleistocene.*—San Pedro; San Diego (Cooper): San Pedro; Ventura; San Diego (Arnold).

*Pliocene.*—San Diego well (Dall).

### 201. **Olivella pedroana** *Conrad.*

*Strephona pedroana* CON., Pac. R. R. Rept., Vol. V, p. 327, Pl. VI, fig. 51, 1854.
*Olivella bœtica* CPR., Brit. Assn. Rept., 1863, p. 661. GABB, Pal. Cal., Vol. II, p. 75, 1869. TRYON, Man. Conch., p. 71, Pl. XVII, figs. 28, 31, 34, 1883. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 255. KEEP, West Coast Shells, p. 42, fig. 21, 1892. WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 212, Pl. XIX, fig. 7.

Shell small, elongate; spire elevated; apex acute; whorls five, flat, smooth; suture appressed, very distinct; aperture elongate-triangular; outer lip thin; inner lip callous; lower part of columella incrusted; columellar plication divided by median groove.

*Dimensions.*—Long. 12.9 mm.; lat. 5 mm.; body-whorl 9.4 mm.; aperture 7.2 mm.; defl. 40 degrees.

Distinguishable from *O. intorta* by double columellar plication, smaller callus, slenderer form, sharper apex and straighter outer lip; distinguishable from *O. biplicata* by slenderer form, smaller size, and more elevated spire.

Common in upper San Pedro series of Los Cerritos; rare in upper and lower San Pedro series, and Pliocene of San Pedro and vicinity. Found also in the Pleistocene at Spanish Bight and Pacific Beach, San Diego, and at Barlow's ranch, Ventura.

*Living.*—Straits of Fuca to San Diego (Cooper).

*Pleistocene.*—Santa Barbara to San Diego (Cooper): San Pedro; Ventura; San Diego (Arnold).

*Pliocene.*—Seven Mile Beach; Twelve Mile House; Kirker's Pass; San Diego well (Cooper).

## Family LV. MARGINELLIDÆ.

### Genus **Marginella** *Lamarck.*

Shell ovately oblong to subcylindrical, smooth, polished, sometimes longitudinally ribbed; spire short, conical, or concealed; aperture narrow, elongated, obtuse or truncated in front; columella plicate; outer lip with a thick marginal varix, its inner margin smooth or crenulated.

*Marginella globella* Linn. is a characteristic species.

### 202. **Marginella jewettii** *Carpenter.*

*Marginella jewettii* CPR., Proc. Zool. Soc., 1856, p. 207; Brit. Assn. Rept., 1863, p. 661. TRYON, Man. Conch., Vol. V, p. 43, Pl. XII, fig. 57, 1883. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 249. DALL, Trans. Wagner Inst. Sci., Vol. III, Part 1, 1890, p. 57. KEEP, West Coast Shells, p. 43, fig. 23, 1892. WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 212, Pl. XIX, fig. 6.

Shell small, smooth, ovate-oblong; spire barely visible; aperture not extending full length of shell, narrow, elongated, obliquely truncated in front; outer lip thickened with marginal varix, its inner side smooth; columella with three prominent plications near anterior end, and lesser ones above.

*Dimensions.*—Long. 5 mm.; lat. 3 mm.; aperture 4.7 mm.

Specimens identified by Dr. Dall.

Found in the lower San Pedro series at Deadman Island and San Pedro, and in the upper San Pedro series at Crawfish George's, San Pedro, and Deadman Island.

*Living.*—Monterey to San Pedro (Dall).

*Pleistocene.*—San Pedro (Cooper; Arnold).

Section *Volvarina Hinds.*

Shell small, pyriform, polished; spire elevated, but concealed by enamel; aperture not extending full length of shell; outer lip thin, with incurving flange; columella with sharp plaits.

### 203. Marginella (Volvarina) varia *Sowerby.*

PLATE IV, FIG. 9.

*Volvarina varia* SBY., CPR., Brit. Assn. Rept., 1863, p. 661. KEEP, West Coast Shells, p. 43, 1892.

Shell small, pyriform, smooth; spire elevated slightly, but concealed by enamel of surface; aperture not extending full length of body-whorl, narrow posteriorly, widening gradually anteriorly; outer lip thin, with a flange curved inward; columella with four sharp plaits.

*Dimensions.*—Long. 9 mm.; lat. 5 mm.; aperture 8 mm.

Specimens identified by Dr. Dall.

Found in all of the lower and upper San Pedro series localities in the vicinity of San Pedro. Found also in the Pleistocene at Twenty-sixth Street, San Diego. The specimen figured is from the lower San Pedro series at Deadman Island, and is now in the collection of Delos Arnold.

*Living.*—Santa Barbara to San Diego (Cooper): Cape St. Lucas; West Indies (Carpenter).

*Pleistocene.*—San Pedro; San Diego (Arnold).

## Family LVI. MITRIDÆ.

### Genus **Mitra** *Lamarck.*

Shell fusiform, thick; spire elevated; aperture small, narrow, notched in front; columella transversely, somewhat obliquely, plicate; outer lip thick, smooth within, without external varices.

Type, *Mitra episcopalis* Lam.

### 204. Mitra maura *Swainson.*

*Mitra maura* SWAIN., Proc. Zool. Soc., p. 193, 1835. CPR., Brit. Assn. Rept., 1863, p. 661. TRYON, Man. Conch., Vol. IV, p. 121, Pl. XXXVI, fig. 67, 1882. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 257. KEEP, West Coast Shells, p. 42, fig. 22, 1892. WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 211.

Shell mitre-shaped; spire elevated; apex subacute; whorls five or six, only slightly convex, each appressed against antecedent whorl, forming a distinct suture; surface smooth, except for incremental lines; aperture long, narrow; outer lip thickened; inner lip not incrusted; columella with four distinct plaits, which increase in prominence posteriorly.

*Dimensions.*—Long. 56 mm.; lat. 18.5 mm.; body-whorl 37 mm.; aperture 25 mm.; defl. 30 degrees.

Found in the lower San Pedro series at San Pedro, and in the upper San Pedro series at Deadman Island, San Pedro and Crawfish George's.

*Living.*—Farallon Islands to San Diego; South America (Cooper).

*Pleistocene.*—Santa Barbara to San Diego; San Nicholas Island (Cooper): San Pedro (Arnold).

*Pliocene.*—San Pedro (Arnold).

### Genus **Mitromorpha** *A. Adams.*

Shell small, elongately fusiform; whorls flattened, with revolving liræ, and sometimes longitudinally plicate; aperture narrow; columella straight, slightly transversely lirate; lip acute, smooth within, scarcely sinuated posteriorly.

*Mitromorpha gracilis* Carpenter is a characteristic species.

### 205. **Mitromorpha filosa** *Carpenter.*

*?Daphnella filosa* CPR., Brit. Assn. Rept., 1863, p. 658.
*Mitromorpha filosa* CPR., KEEP, West Coast Shells, p. 55, 1892. WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 200, Pl. XIX, fig. 1.

Shell small, mitre-shaped; apex rounded; whorls six, flat, ornamented with several sharp, raised, revolving lines; suture impressed, distinct; aperture long, narrow, oblique; outer lip denticulate interiorly; inner lip smooth; columella spirally lined externally.

*Dimensions.*—Long. 8 mm.; lat. 3.6 mm.; body-whorl 6 mm.; aperture 5 mm.; defl. 55 degrees.

A shell from the Pleistocene shows transverse ridges on first four whorls, but these become obsolete below this. This transversely ridged specimen is intermediate between the typical *M. filosa* and *M. intermedia*. *M. aspera* is probably the type of the precursor of the three West Coast species mentioned, then in phylogenetic order would come *M. intermedia*, specimens like the ridged variety of *M. filosa*, and lastly typical *M. filosa*. The cancellate upper whorls of all the species except *M. filosa* show *M. aspera* to be the precursory form.

One specimen in lower San Pedro series of San Pedro.

*Living.*—Santa Barbara (Carpenter): San Pedro (Simpson).

*Pleistocene.*—San Pedro (Arnold).

### 206. **Mitromorpha intermedia,** sp. nov.

PLATE IV, FIG. 10.

Shell small, mitre-shaped; apex rounded; whorls six; slightly convex; whorls ornamented with about four equidistant, sharp, raised spiral lines, and numerous rounded, transverse ridges which are most prominent on angle of whorl; ridges are obsolete, or nearly so, on body-whorl; suture quite deeply impressed; aperture long, narrow, oblique; outer lip slightly arcuate anteriorly, smooth interiorly; inner lip smooth; columella spirally lined externally.

*Dimensions.*—Long. 9.5 mm.; lat. 3.9 mm.; body-whorl 6.5 mm.; aperture 4.5 mm.; defl. 36 degrees.

This species occupies a position nearly midway between *M. filosa* and *M. aspera*. It differs from the first in having distinct transverse ridges on the upper whorls, a smooth inner lip, a slightly slenderer form, and a more impressed suture; and differs from the second in having fewer transverse ridges, which are obsolete, or nearly so, on the body-whorl, a narrower aperture, a slenderer form and more numerous and sharper spiral lines. Pronounced a new variety of *filosa* by Dr. Dall. Its characteristics would ally it a little more readily with *M. aspera*, but it has enough distinctive features to separate it from both.

Rare in lower San Pedro series of Deadman Island.

Found in the Pleistocene at the bath-house, Santa Barbara. The specimen figured is the type, which was found in the lower San Pedro series at Deadman Island, and is now in the United States National Museum.

*Living.*—West Coast (?) (Dall).

*Pleistocene.*—San Pedro; Santa Barbara (Arnold).

## Family LVII. FASCIOLARIIDÆ

### *Subfamily FUSINÆ.*

### Genus **Fusus** *Lamarck.*

Shell fusiform; spire long, acuminate, many-whorled; aperture oval, usually striate within; outer lip simple; columella smooth; no umbilicus; canal long and straight.

*Fusus nicobaricus* Lam. is a characteristic species.

#### 207. **Fusus barbarensis** *Trask.*

PLATE IV, FIG. 15.

*Fusus barbarensis* TRASK, Proc. Cal. Acad. Sci., Vol. I, 1855, p. 41. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 240. WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 217.
*Fusus corpulentus* (not of CONRAD, Wilkes' Expl. Exped., Vol. X, p. 728, Pl. XX, fig. 4, 1849) COOPER, Bull. No. 4, Cal. St. Min. Bureau, Part 3, 1894, p. 26.
*Fusus dupetithouarsi* (*non* KIENER), COOPER, Bull. No. 4, Cal. St. Mining Bureau, Part 3, 1894, p. 26.

Shell of medium size, long, slender, fusiform, rather thin; whorls nine, evenly convex, crossed by about ten rather low, rounded ridges, which fade out toward sutures; body-whorl sometimes lacks these ridges, but in that case it generally has an irregularly, wavy surface ornamented with numerous sharp, raised spiral lines with sometimes smaller lines intercalated; suture deeply appressed; aperture subelliptical; outer lip thin, smooth margin, with prominent, internal spiral lines beginning just posterior to margin; inner lip incrusted, sometimes not covering the spiral sculpture of columella; columella long, nearly straight, except for curve backwards, spirally ridged; canal long, narrow, nearly straight.

*Dimensions.*—Long. 60 mm.; lat. 20 mm.; body-whorl 39 mm.; aperture, including canal, 31 mm.; canal 15 mm.; defl. 32 degrees.

Distinguishable from *F. robustus* and *F. rugosus* by much slenderer form, longer spire, more clear-cut spiral lines, and longer and straighter canal. This is the oldest

form found in this locality. There is no doubt about the close relationship of the three species, *barbarensis*, *robustus* and *rugosus*, as the large series of each which the writer has had during the preparation of this paper shows forms nearly, if not quite, filling the gaps between the three types. *F. barbarensis* is probably the precursor of the other two forms, and although it occurs in the later horizons in which the other two species are the denominating types, still, judging by numbers, this form reached its maximum development in the upper San Pedro series.

Specimens identified by Dr. Dall.

Common in the Pliocene, rare in the lower San Pedro series of Deadman Island; one or two specimens found at each of Deadman Island, San Pedro, and Crawfish George's in the upper San Pedro series. The specimen figured is from the Pliocene at Deadman Island, and is now in the collection of Delos Arnold. This and several other species have been reported from the "Miocene of Deadman Island." Although the lowest horizon at Deadman Island is Miocene, still all of the fossils reported as occurring in the Miocene at that place come out of a Pliocene stratum which rests unconformably upon the Miocene.

*Living*—San Pedro (Oldroyd; Raymond).

*Pleistocene.*—Santa Barbara (Trask; Cooper): San Pedro (Arnold).

*Pliocene*—San Pedro (Arnold).

### 208. Fusus luteopictus *Dall.*

*Fusus luteopictus* DALL, "'Proc. Cal. Acad. Sci.,' 1877, p. 4." (Author's unauthorized reprint, issued March 19, 1877.)
*Fusus ambustus* GLD., CPR., Brit. Assn. Rept., 1863, p. 664 (pars.); (not of GOULD) (*fide* DALL.)
*Fusus geniculus* CONR., GABB, Pal. Cal., Vol. II, p. 71, 1869 (pars. syn. exel.) (*fide* DALL).
*Fusus ambustus* GLD., COOPER, Cal. Monterey Shells, Am. Jour. Conch., Vol. VI, p. 70; Geog. Cat., No. 787 (most Californian writers) (*fide* DALL).
*Fusus luteopictus* DALL, WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 217, Pl. XX, fig. 1.

Shell small, fusiform; whorls five, convex, crossed by nine rounded ridges which reach their maximum development on the middle of whorl; surface ornamented with three or four prominent spiral lines, with finer ones sometimes intercalated; suture appressed; aperture subovate; outer lip not thickened, with internal spiral lines; inner lip incrusted; columella short; canal very short, narrow.

*Dimensions.*—Long. 19 mm.; lat. 10 mm.; body-whorl 13.5 mm.; aperture, including canal, 10 mm.; canal 3 mm.; defl. 38 degrees.

Distinguishable by small size and very short canal.

Rare in the lower San Pedro series at Deadman Island; common in the upper San Pedro series at Crawfish George's, but rare in the same horizon at San Pedro, Deadman Island and Los Cerritos. Most of the specimens obtained came from Crawfish George's.

*Living.*—Farallon Islands to San Diego (Dall).

*Pleistocene.*—San Pedro (Arnold).

### 209. Fusus robustus *Trask.*

*Fusus robustus* TRASK, Proc. Cal. Acad. Sci., Vol. I, 1855, p. 41. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 241.

*Fusus kobelti* (not of DALL), of COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 240 (in part).

Shell of medium size, elongate-fusiform, thick; whorls about six, convex, crossed by eight or nine prominent rounded ridges which are most prominent on angle of whorl (these ridges are sometimes obsolete on the anterior part of the body-whorl); spiral sculpture consists of four to six prominent raised lines, with sometimes smaller lines intercalated; suture appressed, deep, distinct; aperture pyriform; outer lip smooth on inner edge, but with numerous spiral ridges further in; inner lip smooth; columella spirally ridged externally; canal rather short, narrow.

*Dimensions.*—Long. 34 mm.; lat. 14 mm.; body-whorl 22.5 mm.; aperture, including canal, 17 mm.; canal 5 mm.; defl. 40 degrees.

Distinguishable from *F. rugosus* by smaller size, heavier shell, lack of prominent angular appearance of whorls and ridges near posterior suture, less number of whorls and relatively shorter canal. Upon examining a large series of this species and of *F. rugosus* the writer has no hesitancy in separating these two forms of Trask's. Distinguishable from *F. kobelti* by deeper appressed suture, stronger, revolving ridges, narrower form, and lack of wavy sutural band on posterior edge of whorl. *F. robustus* is probably a precursor of *F. kobelti.* This species has been identified as *F. ambustus* by many West Coast conchologists, including Cooper and perhaps Carpenter. Specimens identified by Dr. Dall.

Found only in the upper San Pedro series; rather common at Old San Pedro. Found also in the Pleistocene at the bath-house, Santa Barbara.

*Living.*—Santa Barbara to San Diego (California State Museum).

*Pleistocene.*—Santa Barbara (Cooper; Arnold): San Pedro (Trask; Arnold).

### 210. Fusus rugosus *Trask.*

PLATE IV, FIG. 7.

*Fusus rugosus* TRASK, Proc. Cal. Acad. Sci., Vol. I, 1855, p 41. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 241.

Shell of medium size, elongate, fusiform, thin; whorls eight, convex, crossed by eight to eleven rounded ridges, which rise to greatest prominence on upper side of whorl; body-whorl ventricose and sometimes lacking transverse ridges on forward part; surface ornamented with several prominent raised lines, with fine lines sometimes intercalated; suture deeply appressed, wavy; aperture elliptical; outer lip thin, with interior spiral ridges extending nearly to rim; inner lip smooth; columella long, slightly twisted, spirally ridged; canal long, narrow, slightly curved.

*Dimensions.*—Long. 50 mm.; lat. 19 mm.; body-whorl 35 mm.; aperture, including canal, 28 mm.; canal 13 mm.; defl. 44 degrees.

The specimen described and figured is a small one. Some of the specimens are over 65 mm. in length.

Distinguishable from *F. robustus* by larger size, thinner shell, longer canal, more ventricose body-whorl, and greater development of transverse ridges on upper portion of whorl. Perhaps *F. rugosus* is the precursor of *F. robustus.* If so, then

*robustus* is a degenerate form in so far as size and beauty go, for *rugosus* is truly a magnificent shell, while the former is small and much less attractive. This species has been identified as *F. ambustus*, and is so labeled in the State Museum collection at Berkeley. *F. ambustus* of Gould is a slenderer, longer pillared form from Central America.

Found only in the lower San Pedro series of Deadman Island. The shells in this horizon are beautifully preserved, this form especially being nearly always found in a perfect condition, and having a shell that in most cases is translucent. Rather rare. The specimen figured is from the lower San Pedro series at Deadman Island, and is now in the collection of Delos Arnold.

*Living.*—Santa Barbara to San Diego (California State Museum).

*Pleistocene.*—Santa Barbara (Cooper): San Pedro (Arnold; Trask).

### Genus **Pisania** *Bivona.*

Shell oblong; spire prominent; whorls smooth or spirally striated; canal very short; outer lip thickened and crenated.

*Pisania pusio* Linn. is a characteristic species.

### 211. **Pisania fortis** *Carpenter.*

*Pisania fortis* CPR., Ann. & Mag. Nat. Hist., 3rd Ser., Vol. XVII, 1866, p. 277. COOPER, 7th Ann. Rept. Cal. St. Min.. 1888, p. 260.

Shell fusiform, short; spire elevated; apex subacute; whorls five or six, convex on upper whorls to angular on body-whorls; eight wave-like ribs, most prominent on the angle of the whorl; prominent sutural riblet on posterior margin of whorl; surface ornamented with three to five prominent, squarish, rough, revolving ridges, between which are finer raised lines; suture wavy, appressed, distinct; aperture pyriform; outer lip denticulated; umbilicus subperforate.

*Dimensions.*—Long. 49 mm.; lat. 29 mm.; body-whorl 38 mm.; aperture 25 mm.; defl. 58 degrees.

This species resembles some specimens of *Purpura crispata*, but is a lighter shell, and the sculpture is entirely different. Originally described from a specimen from the Pleistocene of Santa Barbara. It has never been found living.

Rare in the upper San Pedro series of San Pedro and Deadman Island; two specimens found. Found in the Pleistocene at Pacific Beach, San Diego.

*Pleistocene.*—Santa Barbara (Cooper): San Pedro; San Diego (Arnold).

## Family LVIII. BUCCINIDÆ.

### Genus **Chrysodomus** *Swainson.*

Shell fusiform, ventricose; spire elevated; whorls rounded; covered with a horny epidermis; apex papillary; aperture oval; canal short; inner lip simple, smooth.

*Chrysodomus antiqua* Linn. is a characteristic species.

### 212. Chrysodomus rectirostris *Carpenter.*

PLATE VII, FIG. 7.

*Chrysodomus rectirostris* CPR., Brit. Assn. Rept., 1863, p. 664; Proc. Phil. Acad. Nat. Sci., 1865, p. 64. TRYON, Man. Conch., Vol. II, p. 131, Pl. LIII, fig. 348, 1881.

Shell small, turreted, slender; apex acute; whorls nine or ten, slightly convex, with about fourteen rounded, transverse ridges reaching from suture to suture; ridges follow direction of lines of growth, which are convex anteriorly; spiral sculpture consists of numerous fine furrows; suture impressed, distinct; body-whorl slightly angulated at base; aperture elliptical; outer lip thin, bulging above canal; inner lip smooth, incrusted; columella long, straight, narrow, smooth on inner part; canal long, straight, narrow.

*Dimensions.*—Long. 28 mm.; lat. 7 mm.; body-whorl 14.5 mm.; aperture, including canal, 11.5 mm.; canal 5 mm.; defl. 22 degrees.

This species looks something like a *Pleurotoma*, but may be distinguished by the straight canal and almost flat whorls. Carpenter's description in the British Association Report for 1863 is misleading. In describing this species he says the shell is "small, white, smooth, with straight canal." Why he uses "smooth" in describing such a decidedly sculptured form is not easy to understand. Several specimens of this species were identified from Carpenter's type by Dr. Dall.

Rare in the Pliocene and lower San Pedro series at Deadman Island, and in the upper San Pedro series at Crawfish George's. The specimen figured is from the lower San Pedro series at Deadman Island, and is now in the collection of Delos Arnold.

*Living.*—Puget Sound (Carpenter).

*Pleistocene.*—San Pedro (Arnold).

### 213. Chrysodomus tabulatus *Baird.*

PLATE VII, FIG. 6.

*Chrysodomus tabulatus* BAIRD, Proc. Zool. Soc., 1863, p. 66. CPR., Brit. Assn. Rept., 1863, p. 663; Nat. in British Columbia, Vol. II, p. 356. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 235.

*Neptunea tabulata* BAIRD, GABB, Pal. Cal., Vol. II, p. 71, 1869. TRYON, Man. Conch., Vol. II, p. 121, Pl. XLIX, fig. 286, 1881.

Shell large, fusiform; spire elevated; apex subacute; whorls eight, sharply angulated and keeled above, forming a rimmed, spiral table; surface ornamented with revolving ridges of alternating size; suture very deeply impressed; aperture pyriform; outer lip thin, smooth; inner lip incrusted; canal long, narrow, curved backwards; columella twisted, spirally ridged.

*Dimensions.*—Long. 80 mm.; lat. 34 mm.; body-whorl 55 mm.; aperture, including canal, 42 mm.; canal 19 mm.; defl. 44 degrees.

Rather common in Pliocene; rare in lower San Pedro series of Deadman Island and San Pedro. Found also in the Pleistocene at the bluff west of the bath-house, Santa Barbara, and at the old irrigating ditch north of Ventura. The

specimen figured was from the Pliocene, Deadman Island, and is now in the collection of Delos Arnold.

*Living.*—Straits of Fuca to Catalina Island (Cooper).

*Pleistocene.*—San Pedro; Santa Barbara; Ventura (Arnold).

*Pliocene.*—Eagle Prairie; Twelve Mile House; San Fernando; Santa Barbara (Cooper); San Pedro (Cooper; Arnold).

### 214. **Chrysodomus,** sp. indet.

Two poorly preserved, undeterminable species; both fusiform, one with rounded whorls, the other slightly tabulated on upper part; fine spiral sculpture on both. These specimens have the shape of *C. dirus.* They correspond quite closely to the descriptions of some of the living species which now inhabit boreal waters.

Found in the Pliocene of Deadman Island.

*Pliocene.*—San Pedro (Arnold).

### Genus **Siphonalia** *A. Adams.*

Shell ovately fusiform, sometimes variegated in coloring; rather thin; epidermis very thin, fugacious; last whorl ventricose, shouldered, usually nodosely plicate and spirally ribbed; aperture oval; outer lip thin; columella smooth; canal rather short, twisted.

*Siphonalia nodosa* Mart. is a characteristic species.

### 215. **Siphonalia kellettii** *Forbes.*

PLATE IV, FIG. 5.

*Siphonalia kellettii* FORBES, Proc. Zool. Soc., 1850, p. 274, Pl. X, fig. 10. CPR., Brit. Assn. Rept., 1863, p. 663. TRYON, Man. Conch., Vol. III, p. 134, Pl. LIV, fig. 352. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 264. DALL, Trans. Wagner Inst. Sci., Vol. III, Part. I, 1890, p. 122. KEEP, West Coast Shells, p. 22, 1892.

Shell large, fusiform; spire elevated; apex subacute; whorls seven or eight, angulated anterior to middle with eight to ten prominent nodes on angle; concave near posterior margin, where it is appressed against the antecedent whorl; numerous fine, deep grooves furnish the spiral ornamentation; suture appressed, wavy; aperture ovate; outer lip not thickened; inner lip incrusted; columella twisted; umbilicus subperforate; canal long, narrow, curved back.

*Dimensions.*—Long. 114 mm.; lat. 59 mm.; body-whorl 80 mm.; aperture 37 mm.; canal 22 mm.; defl. 44 degrees.

Often brought up alive in the nets of fishermen at San Pedro, but rarely found fossil. Found in the upper San Pedro series at San Pedro, Los Cerritos, and Crawfish George's. Found also in the Pleistocene at Pacific Beach, San Diego. The specimen figured was obtained in the upper San Pedro series at San Pedro, and is now in the private collection of Delos Arnold.

*Living.*—Santa Barbara to San Diego; Japan (Cooper).

*Pleistocene.*—San Pedro to San Diego (Cooper): San Pedro; San Diego (Arnold).

Genus **Macron** *H. & A. Adams.*

Shell ovate, solid, with a thick epidermis; spire elevated; columella wrinkled, with a callosity at the upper part; outer lip thin, with a small tooth anteriorly.

Type, *Macron kellettii* A. Ads.

### 216. Macron kellettii *A. Adams.*

*Pseudoliva kellettii* A. AD., Proc. Zool. Soc., 1853, p. 185.
*Macron kellettii* A. AD., CPR., Brit. Assn. Rept., 1863, p. 664. TRYON, Man. Conch., Vol. III, p. 214, Pl. LXXXII, fig. 477, 1881. KEEP, West Coast Shells, p. 21, 1892. COOPER, Bull. No. 4, Cal. St. Min. Bureau, Part 3, 1894, p. 27.

Shell ovate, solid, subperforate; spire prominent; whorls rounded; suture canal-like; last whorl spirally sulcated; aperture oval; columella callous posteriorly, anterior portion produced and flexed; posterior part of lip bent, anterior part dentate. Canal a mere notch. Average length about 25 mm.

One specimen in upper San Pedro series of San Pedro.

*Living.*—Lower California (Keep): Catalina Island to Lower California (Cooper).

*Pleistocene.*—San Pedro (Arnold): San Joaquin Bay, Orange County (Bowers).

*Pliocene.*—Ventura County (Bowers).

### 217. Macron lividus *A. Adams.*

*Macron lividus* A. AD., CPR., Brit. Assn. Rept.. 1863, p. 664. KEEP, West Coast Shells, p. 20, fig. 2, 1892. WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 216.

Shell small, ovate, solid; spire elevated; apex subacute; whorls five, evenly convex, smooth; suture distinct; aperture ovate; outer lip sharp and curved; inner lip short and bent; columella with a strong fold near the top of the aperture.

*Dimensions.*—Long. 19 mm.; lat. 10 mm.; body-whorl 14 mm.; aperture 10 mm.

This species is characterized by its smooth surface and small size. One specimen found in the upper San Pedro series at the lumber yard, San Pedro.

*Living.*—San Pedro (Williamson): San Diego to Lower California (Carpenter).

*Pleistocene.*—San Pedro (Arnold).

## Family LIX. NASSIDÆ.

Genus **Nassa** *Lamarck.*

Shell ovate,ventricose; body-whorl variously sculptured; aperture ovate, with a short, reflected, truncated, anterior canal; inner lip smooth; often widely spread over with enamel, with a posterior callosity or a blunt dentiform; outer lip dentated, internally crenulated.

*Nassa mutabilis* Linn. is a characteristic species.

### 218. Nassa californiana *Conrad.*

PLATE IV, FIG. 3.

*Schizopyga californiana* CON., Proc. Phil. Acad. Nat. Sci., 1856, p. 315; Pac. R. R. Rept., Vol. VI p. 69, Pl. II, fig. 1, 1857.
*Schizopyga californica* CON., TRYON, Man. Conch., Vol. IV, p. 55, Pl. III, fig. 32, 1882.
*Nassa californiana* CON., DALL, Proc. U. S. Nat. Mus., Vol. XIV, 1891, p. 177. COOPER, Bull. No. 9, Cal. St. Min. Bureau, Part 3, 1894, p. 29.
*Nassa fossata* var., GABB, Pal. Cal., Vol. II, pp. 47, 74, 1869.

Shell large, conical; whorls seven, convex, ornamented with about thirteen prominent, rounded, posteriorly sloping, transverse ribs and four or five slightly less prominent sharp, revolving ridges; the transverse ridges tend to become less prominent on the anterior part of the body-whorl; suture deeply impressed, distinct; aperture subovate; outer lip thin and denticulated by ends of internal revolving ridges; inner lip slightly incrusted; columella short, twisted, spirally and longitudinally ornamented, and deeply grooved next to body-whorl; anterior sinus very short, broad, recurved.

*Dimensions.*—Long. 37 mm.; lat. 20.5 mm.; body-whorl 24 mm.; aperture 16.5 mm.; defl 48 degrees.

The most beautiful and one of the largest of the Pleistocene *Nassas.* Easily distinguishable by the ornamentation and size.

Rare in the upper San Pedro series, except at one place in the bluff just north of the town of San Pedro, where quite a few very fine specimens have been found; also found in the Pliocene and lower San Pedro series at Deadman Island; and in the upper San Pedro series at Los Cerritos, Deadman Island, and Long Beach. Found also in the Pleistocene at Barlow's ranch, Ventura; and at Pacific Beach, San Diego. The specimen figured is from the upper San Pedro series of San Pedro; and is now in the private collection of Delos Arnold.

*Living.*—Drake's Bay to Cedros Island, Lower California (Cooper).

*Pleistocene.*—San Pedro; Ventura; San Diego (Arnold).

*Pliocene.*—San Pedro (Arnold).

*Miocene.*—Santa Clara County (Cooper).

### 219. Nassa cerritensis, sp. nov.

PLATE IV, FIG. 1.

Shell small, conical; spire elevated; apex subacute; whorls eight, slightly convex, crossed by seven to ten prominent, rounded ridges which are less prominent near the suture; spiral sculpture consists of nine to eleven sharp, raised lines; three upper whorls have a cancellate appearance; suture appressed, wavy; aperture ovate; outer lip thickened by denticulated ridge on inner side; inner lip smooth, incrusted, the incrustation completely covering the spiral sculpture internally; columella twisted, spirally sculptured, with deep groove next to body-whorl; canal short, broad, recurved.

*Dimensions.*—Long. 30 mm.; lat. 14.5 mm.; body-whorl 18 mm.; aperture 11 mm.; defl. 30 degrees.

This species varies much, especially in deflection and in the number of transverse ridges. The deflection of the upper whorls is sometimes as high as 60 degrees,

while that of the lower whorls would be about one-half of that. Some of the adult shells also show a deflection of 50 degrees. The robust shells as a rule show more transverse ridges than the slenderer forms. Distinguishable from var. *cooperi* by less angulated whorls and ridges, less impressed suture, greater deflection of upper whorls, and larger size. The robust form somewhat resembles *N. californiana,* but is distinguishable from that species by its appressed, rather than impressed suture, less prominence of spiral lines, and smaller size. Dr. Dall pronounces this species a precursor of *N. cooperi.*

Rather common at Los Cerritos, where the type was found. One or two specimens found in the upper San Pedro series at San Pedro, Long Beach, and Crawfish George's. Found also in the Pleistocene at Spanish Bight, San Diego. The specimen figured is the type, which came from the upper San Pedro series at Los Cerritos, and is now in the United States National Museum.

*Pleistocene.*—San Pedro; San Diego (Arnold).

### 220. Nassa fossata *Gould.*

*Buccinum fossatum* GLD., Proc. Bost. Soc. Nat. Hist., 1850, p. 152. OTIA, Conch., p. 67, 1862.
*Nassa fossata* GLD., H. & A. ADAMS, Gen. Rec. Mollusca. CPR., Brit. Assn. Rept., 1863, p. 662. GABB, Pal. Cal., Vol. II, p. 74, 1869. TRYON, Man. Conch., Vol. IV, p. 55, Pl. XVII, figs. 316, 318, 1882. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 253. KEEP, West Coast Shells, p. 36, fig. 16, 1892. WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 212.

Shell small, conical; spire elevated; apex subacute; whorls seven, convex; body-whorl ventricose; ornamentation of fourth and fifth whorl consists of five or six strong, nodose, spiral ridges which increase in number by intercalation on the lower whorls; the prominence of the nodes varies inversely with the number of ridges, the ridges on the body-whorl being nearly smooth and alternating large and small; the ridges near the angle of the whorl reach the greatest prominence; suture deeply impressed, distinct; aperture ovate; outer lip thickened and denticulated by ends of revolving internal ridges; inner lip incrusted, the incrustation spreading over part of body-whorl and columella; columella short, curved, spirally striated, and grooved deeply next to body-whorl; anterior sinus short, broad, recurved.

*Dimensions.*—Long. 29 mm.; lat. 17 mm.; body-whorl 21 mm.; aperture, including canal, 14.5 mm.; defl. 50 degrees.

The adolescent shell of this species resembles *N. perpinguis,* but may be distinguished by the greater convexity of the body-whorl, greater deflection, and general more solid appearance. The adult shells are characterized by their general solid appearance, great deflection, and the great difference in sculpture between the upper and lower whorls.

Found in the Pliocene at Deadman Island; in the lower San Pedro series at Deadman Island and San Pedro, and in the upper San Pedro series at all of the localities in the vicinity of San Pedro. Found also in Pleistocene at Spanish Bight and Pacific Beach, San Diego; and at old irrigating ditch and Barlow's ranch,

Ventura. The specimens of this species found at Crawfish George's are characterized by their large size and elevated spire, with deeply impressed suture.

*Living.*—Straits of Fuca to San Diego (Cooper).

*Pleistocene.*—Santa Barbara to San Diego (Cooper): San Pedro; Ventura; San Diego (Arnold).

*Pliocene.*—Danger Creek; Santa Rosa; Soquel, Santa Cruz County; San Diego well (Cooper): San Pedro (Arnold).

*Miocene.*—Martinez; Walnut Creek; Griswold's, San Benito County; Foxin's, Santa Barbara County (Cooper).

### 221. Nassa insculpta *Carpenter.*

*Nassa insculpta* CPR., Brit. Assn. Rept., 1863, p. 662; Proc. Cal. Acad. Sci., Vol. III, 1866, p. 223. TRYON, Man. Conch., Vol. IV, p. 38, Pl. XII, fig. 154, 1882; (not of COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 253). WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 212, Pl. XXIII, fig. 6.

Shell small, conical; spire elevated; apex subacute; whorls seven, nearly flat, but obliquely truncated near margin; sculpture consists of numerous fine, spiral furrows, which are most prominent on lower portion of body-whorl; four upper whorls have prominent transverse ridges; aperture subquadrate; outer lip thickened by a slightly denticulated ridge; inner lip incrusted slightly, but spiral ornamentation shows through the incrustation; columella short and separated from body-whorl by deep, narrow groove; canal short, broad, curved.

*Dimensions.*—Long. 20 mm.; lat. 11 mm.; body-whorl 12.8 mm.; aperture, including canal, 9 mm.; defl. 38 degrees.

Distinguishable by lack of any but spiral ornamentation on lower whorls. A specimen in the State Museum collection at Berkeley labeled *N. insculpta* is not the species, but is close to *N. versicolor* var. *hooveri.* This is probably the specimen upon which Cooper bases his report of the occurrence of *N. insculpta* at Santa Barbara. Rare in upper San Pedro series of San Pedro; one specimen.

*Living.*—Catalina Island (Cooper; Raymond).

*Pleistocene.*—San Pedro (Williamson; Arnold).

### 222. Nassa mendica *Gould.*

*Nassa mendica* GLD., Proc. Bost. Soc. Nat. Hist., 1850, p. 155. Wilkes' Expl. Exped., Vol. XII, p. 263, Pl. XIX, fig. 331, 1852. OTIA, Conch., p. 70, 1862. CPR., Brit. Assn. Rept., 1863, p. 662; =*M. woodwardi* FBS.; =*N. gibbsii* COOPER (*fide* TRYON, Man. Conch., Vol. IV, p. 56, Pl. XVII, figs. 320-323, 1882). GABB, Pal. Cal., Vol. II, p. 74, 1869. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 253. KEEP, West Coast Shells, p. 37, 1892. WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 213.

Shell small, conical; spire elevated; apex acute; whorls seven, convex; ornamented with a varying number of transverse ridges and a few less prominent spiral ridges; suture deeply impressed, distinct; aperture subquadrate; outer lip thin, smooth on edge, but denticulated remote from margin; inner lip incrusted; columella curved, spirally striated, and separated from body-whorl by deep groove; canal short, recurved.

*Dimensions.*—Long. 18.5 mm.; lat. 8 mm.; body-whorl 11 mm.; aperture, including canal, 7.5 mm.; defl. 38 degrees.

A species varying principally in the number and prominence of transverse ridges. Distinguishable from *N. perpinguis* by acuteness of spire.

Found in all of the fossiliferous formations at all of the localities in the vicinity of San Pedro. *N. mendica* is much rarer than the variety *cooperi*. Found in the Pleistocene at the bath-house, Santa Barbara; at Barlow's ranch, and the old irrigating ditch, Ventura; and at Spanish Bight and Pacific Beach, San Diego.

*Living.*—Sitka to San Diego (Cooper).

*Pleistocene.*—Santa Barbara to San Diego (Cooper): San Pedro; Santa Barbara; Ventura; San Diego (Arnold).

*Pliocene.*—Kirker's Pass; Twelve Mile House, San Mateo County; San Diego well (Cooper): San Pedro (Arnold).

### 223. Nassa mendica *Gould*, var. cooperi *Forbes.*

*Nassa cooperi* FBS., Proc. Zool. Soc., 1850, p. 273, Pl. XI, fig. 4. CPR., Brit. Assn. Rept., 1863, p. 662. GABB, Pal. Cal., Vol. II, p. 74, 1869. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 253. KEEP, West Coast Shells, p. 37, fig. 18, 1892.

*Nassa mendica* var. *cooperi* FBS., TRYON, Man. Conch., Vol. IV, p. 56, Pl. XVII, figs. 322, 323, 1892. WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 213.

Shell like *N. mendica*, except that the transverse ridges are more prominent and less numerous. Mutations occur between the extreme *N. mendica* with latticed ornamentation consisting of equally prominent spiral and transverse ridges, and the extreme *N. cooperi* with only six large, transverse ribs.

More common than the typical *N. mendica.* Found in the lower and upper San Pedro series and Pliocene of the San Pedro region. Found in the Pleistocene at Pacific Beach, San Diego.

*Living.*—Sitka to San Diego (Cooper): Catalina Island (Stearns).

*Pleistocene*—Santa Barbara to San Diego (Cooper): San Pedro; San Diego (Stearns; Arnold).

*Pliocene.*—Kirker's Pass; Twelve-mile House, San Mateo County; San Diego well (Cooper): San Pedro (Arnold).

### 224. Nassa perpinguis *Hinds.*

*Nassa perpinguis* HDS., Voyage Sulphur, p. 36, Pl. IX, figs. 12, 13, 1844. CPR., Brit. Assn. Rept., 1863, p. 662; GABB, Pal. Cal., Vol. II, pp. 47, 75, 1869. TRYON, Man. Conch., Vol. IV, p. 56, Pl. XVII, fig. 319, 1882. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 253. KEEP, West Coast Shells, p. 38, fig. 19, 1892. WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 213.

*Nassa interstriata*, CON., Pac. R. R. Rept., Vol. V, p. 327, Pl. VI, fig. 49, 1856.

Shell small, conical; spire elevated; apex subacute; whorls seven, convex, abruptly truncated at posterior margin, forming a spiral table; ornamentation consists of sharp, spiral ridges with slightly wider interspaces, and posteriorly sloping transverse ridges, the whole giving a decidedly cancellate appearance to the surface; suture deeply impressed, distinct; aperture subovate; inner

portion of aperture ridged by spiral sculpture; outer lip thin; inner lip thinly incrusted; columella twisted and spirally ornamented; groove on upper part of columella prominent; canal short, curved.

*Dimensions.*—Long. 23 mm.; lat. 12.3 mm.; body-whorl 15 mm.; aperture, including canal, 11 mm.; defl. 40 degrees.

The transverse ornamentation is the most prominent in the upper whorls, while in the later ones the spiral ridges are the most important. On the body-whorl the tranverse ridges sometimes become nearly obsolete, being represented only by lines of growth.

Common in the upper and rare in the lower San Pedro series at San Pedro and vicinity. Also found in the Pliocene at Deadman Island and Timm's Point. Found in the Pleistocene at Spanish Bight and Pacific Beach, San Diego; and at the old irrigating ditch and Barlow's ranch, Ventura.

*Living.*—San Francisco to San Diego; Lower California (Cooper).

*Pleistocene.*—Santa Barbara to San Diego (Cooper): San Pedro; Ventura; San Diego (Arnold).

*Pliocene.*—San Diego well (Dall): San Pedro (Arnold).

*Miocene.*—Santa Monica and Aliso Creek, Los Angeles County (Cooper).

### 225. Nassa tegula *Reeve.*

*Nassa tegula* RVE., Icon. Conch., *Nassa*, No. 98, Pl. XV, 1853. CPR., Brit. Assn. Rept., 1863, p. 662. GABB, Pal. Cal., Vol. II, p. 74, 1869. TRYON, Man. Conch., Vol. IV, p. 39, Pl. XIII, figs. 166, 167, 1882. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 253. KEEP, West Coast Shells, p. 37, fig. 17, 1892. DALL, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 213.

Shell small, conical; spire elevated; apex subacute; whorls five, slightly angulated at middle, with nine or ten prominent transverse ridges most prominent on angular part of whorl; these ridges are sometimes divided by spiral grooves into two or more nodes; suture impressed, distinct; aperture subquadrate; outer lip thickened by a row of elongated denticles; inner lip smooth and incrusted, the incrustation spreading over the columella and the front of the shell like an apron; a rather shallow groove separates the lower portion of columella from body-whorl; canal very short.

*Dimensions.*—Long. 11 mm.; lat. 7 mm.; body-whorl 7.9 mm.; aperture, including canal, 5 mm.; defl. 58 degrees.

The most robust of the *Nassas* found in this locality. Distinguishable by the prominence of the incrustation on the inner lip. Dr. Dall says that this species is close to *N. vibex* of the Atlantic coast.

Rare in the upper San Pedro series at San Pedro, Los Cerritos, Long Beach, Deadman Island, and Crawfish George's; also occasionally found in the lower San Pedro series at Deadman Island and San Pedro. Found also in the Pleistocene at Twenty-sixth Street and Spanish Bight, San Diego.

*Living.*—Santa Barbara to San Diego; Lower California (Cooper).

*Pleistocene.*—Santa Barbara to San Diego (Cooper): San Pedro; San Diego (Arnold).

### 226. Nassa versicolor *C. B. Adams*, var. hooveri, var. nov.

PLATE IV, FIG. 6.

*Nassa versicolor* C. B. AD., Panama Cat., p. 66, 1852. TRYON, Man. Conch., Vol. IV, p. 50, Pl. XV, figs. 270–272, 275, 1882.

Shell small, conical; spire not highly elevated; apex subacute; whorls six, slightly convex, crossed by fifteen prominent rounded ribs which bend slightly forward on the upper whorls, and are abruptly truncated at the sutures; on the body-whorl these ribs are concave anteriorly and become obsolete on the lower portion of the whorl; ribs on the upper whorls are of uniform size for their full length; suture deeply impressed, distinct; spiral ornamentation consists of eleven to thirteen grooves, which extend to base on body-whorl; columella extended, plication on inner side, and deep, narrow groove around it at base of body-whorl; outer lip thickened by a prominent, smooth ridge on the inner side; inner lip incrusted, the spiral sculpture, however, showing through the incrustation; canal short, broad, with effuse lips.

*Dimensions.*—Long. 14.5 mm.; lat. 9 mm.; body-whorl 10 mm.; aperture, including canal, 7 mm.; defl. 54 degrees.

A unique form for this locality; somewhat resembles *N. tegula* in shape, but easily distinguishable from that species by the sculpture. Pronounced a variety of *N. versicolor* Adams, by Dr. Dall. *N. versicolor* is found in the southern fauna, its habitat being Panama to Mazatlan according to Tryon.

Rare in upper San Pedro series of San Pedro; two specimens found, one a junior. The specimen figured is the type, which was obtained from the upper San Pedro series of San Pedro, and is now in the United States National Museum.

*Pleistocene.*—San Pedro (Arnold).

## Family LX. COLUMBELLIDÆ.

### Genus Columbella *Lamarck.*

Shell strombiform or obovate, smooth or longitudinally or tranversely ribbed; internal lip excavated in the middle, crenulated or denticulated; outer lip inflected and internally thickened and crenulated in the middle.

*Columbella mercatoria* Lam. is a characteristic species.

### 227. Columbella solidula *Reeve*, var. præcursor, var. nov.

PLATE X, FIG. 4.

*Columbella solidula* RVE., Conch. Icon., Vol. XI, Pl. XXIV, fig. 149, 1859. TRYON, Man. Conch., Vol. V, p. 147, Pl. LII, figs. 92 and 93, 1883.

Shell small, broadly fusiform; spire elevated; apex rounded; whorls seven, only slightly convex, slightly shouldered above, smooth; body-whorl two-thirds length of shell, with row of nodes on shoulder, each node being the termination of a faint transverse ridge which becomes obsolete on lower portion of whorl; columella with spiral sulcations on exterior; aperture rhomboidal, narrow; outer lip thickened internally by row of prominent teeth; inner lip smooth; canal short, recurved.

*Dimensions.*—Long. 14.5 mm.; lat. 6.5 mm.; body-whorl 10 mm.; aperture, including canal, 7.5 mm.; canal 1 mm.; defl. 42 degrees.

This unique species is distinguishable by its smooth upper whorls, and sculptured body-whorl. Pronounced a variety of *C. solidula* Rve. by Dr. Dall.

The shell of which this form is a variety is found living on the coast of Ecuador, South America. The type is the only specimen that has been found in the upper San Pedro series at San Pedro; it is figured, and is now in the United States National Museum.

*Pleistocene.*—San Pedro (Arnold).

### Subgenus **Anachis** *H. & A. Adams.*

Shell oval-fusiform, longitudinally ribbed; spire elevated; aperture narrow; columella straight; outer lip nearly straight, crenulated within.

*Anachis rugosa* Sowerby is a characteristic species.

### 228. **Columbella (Anachis) minima,** sp. nov.

PLATE IX, FIG. 8.

Shell small, resembles a young *Amphissa corrugata* but much slenderer; surface sculptured by numerous transverse ridges and fine spiral sulcations; whorls six, shouldered above as in *Amphissa versicolor;* aperture subquadrate; outer lip nearly straight; pillar straight, spirally striated.

*Dimensions.*—Long. 6 mm.; lat. 2.4 mm.; body-whorl 3.5 mm.; aperture 2.2 mm.; defl. 28 degrees.

Distinguishable from *Amphissa corrugata* by slenderer form, more shouldered whorls and less wavy transverse ridges. Pronounced a new species of *Anachis* by Dr. Dall.

Type from upper San Pedro series of San Pedro; rare. The specimen figured is the type, which is now in the United States National Museum.

*Pleistocene.*—San Pedro (Arnold).

### Subgenus **Æsopus** *Gould.*

Shell fusiform, gibbous, broadly truncate in front; aperture lunate, with a posterior callous on the body; columella smooth, vitreous; suture abnormally arcuate near the aperture.

Type, *Æsopus japonicus* Gould.

### 229. **Columbella (Æsopus) chrysalloidea** *Carpenter.*

PLATE V, FIG. 6.

*Amycla chrysalloidea* CPR., Brit. Assn. Rept., 1863, p. 612; Proc. Cal. Acad. Sci., Vol. III, 1864, p. 223.
*Columbella chrysalloidea* CPR., TRYON, Man. Conch., Vol. V, p. 135, Pl. L, fig. 42, 1883.
*Astyris chrysalloidea* CPR., KEEP, West Coast Shells, p. 36, 1892.
*Columbella (Æsopus) chrysalloidea* CPR., WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 213.

Shell small, with general elongate-elliptical outline, or chrysalis-shaped; spire elevated, subacute; whorls six, very slightly convex; surface marked by delicate spiral ridges and furrows;

aperture ovate; canal short; outer lip thickened by several longitudinally elongate denticles on inner side; inner lip curved, smooth; spiral ornamentation prominent on lower portion of columella.

*Dimensions.*—Long. 8.2 mm.; lat. 3 mm.; body-whorl 5.5 mm.; aperture 3.4 mm.; defl. 44 degrees.

Rare in the lower San Pedro series at Deadman Island and San Pedro; not uncommon in the upper San Pedro series at San Pedro. Found also in the Pleistocene at Twenty-sixth street, San Diego. The specimen figured is from the upper San Pedro series at San Pedro, and is now in the collection of Delos Arnold.

*Living.*—San Pedro to San Diego (Cooper).

*Pleistocene.*—San Pedro; San Diego (Arnold).

### 230. **Columbella (Æsopus) oldroydi,** sp. nov.

PLATE VI, FIG. 7.

Shell small, slender, fusiform; spire elevated; apex rounded; whorls seven, convex; first three whorls smooth, remainder, with exception of body-whorl, ornamented with about eighteen transverse ridges and two or three rather indistinct spiral grooves, the whole giving a cancellate appearance to the surface; on the body-whorl the transverse and spiral sculpture are of about equal prominence, the transverse sculpture being more subdued than on the whorls above it; suture quite deeply impressed; aperture narrow, elliptical; pillar truncated anteriorly; outer lip smooth, thin; inner lip smooth.

*Dimensions.*—Long. 9 mm.; lat. 2.6 mm.; body-whorl 5 mm.; aperture 3 mm.; defl. 24 degrees.

Distinguishable from *A. chrysalloidea* by slenderer form, prominently sculptured surface, deeper suture, and smooth inner lip. Pronounced a new species by Dr. Dall.

Lower San Pedro series at Deadman Island; rare. The specimen figured is the type, and is now in the collection of Mrs. Oldroyd.

*Pleistocene.*—San Pedro (Arnold).

## Subgenus **Astyris** *H. & A. Adams.*

Shell oval-fusiform, smooth or transversely striated; aperture oval; inner lip smooth, not callous; outer lip sinuous posteriorly, crenulated within.

*Astyris clausiliæforme* Kiener is a characteristic species.

### 231. **Columbella (Astyris) californiana** *Gaskoin.*

PLATE X, FIG. 9.

*Columbella (Astyris) californiana* GASK., Proc. Zool. Soc., 1851, p. 12.
*Columbella californiana* GASK., CPR., Brit. Assn. Rept., 1856, p. 341.

This species resembles *A. gausapata* quite closely, but differs from it in the following respects: it is slightly broader, has more swelling whorls, more prominent

spiral lines on the lower part of the body-whorl, does not have the overlapping appearance of the whorls at the suture as much as in *A. gausapata*, has a less heavy shell, and has a less glossy surface. Specimen identified by Dr. Dall.

Rare in the lower San Pedro series at Deadman Island, also found in the lower San Pedro series at San Pedro. The specimen figured is from the lower San Pedro series at Deadman Island, and is now in the collection of Delos Arnold.

*Living.*—Santa Barbara to San Diego (Carpenter).

*Pleistocene.*—San Pedro (Oldroyd; Arnold).

### 232. Columbella (Astyris) gausapata *Gould.*

PLATE X, FIG. 8.

*Columbella gausapata* GLD., Proc. Bost. Soc. Nat. Hist., 1850, p. 170; Wilkes' Expl. Exped., Vol. XII, p. 267, Pl. XIX, fig. 337, 1852.
*Nassa pedroana* CON., Pac. R. R. Rept., Vol. V, p. 327, Pl. VI, fig. 48, 1856.
*Amycla gausapata* GLD., CPR., Brit. Assn. Rept., 1863, p. 662. GABB, Pal. Cal., Vol. II, p. 76, 1869. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 229.
*Astyris gausapata* GLD., KEEP, West Coast Shells, p. 35, fig. 15, 1892.
*Columbella* (*Astyris*) *gausapata* GLD., WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 213.

Shell small, rather heavy; spire elevated; apex acute; whorls seven, slightly convex; body-whorl ventricose, slightly angulated; whorls smooth except for delicate incremental lines; suture depressed, distinct; columella recurved and striated on outside with faint spiral ridges and grooves; aperture elongate-ovate; canal prominent, slightly curved; outer lip thickened with a row of spirally elongate denticles; inner lip smooth.

*Dimensions.*—Long. 11 mm.; lat. 5 mm.; body-whorl 7 mm.; aperture (not including canal) 3 mm. × 1.9 mm.; defl. 35 degrees.

Distinguishable from *C. californiana* by much longer canal, thicker shell, and more prominent denticulation of outer lip; distinguishable from *C. tuberosa* by broader spire and less angulated body-whorl; distinguishable from var. *carinata* by lack of keel, and slenderer spire. Specimens identified by Dr. Dall.

Found in all of the formations at all of the localities in the vicinity of San Pedro. Found also in the Pleistocene at the bath-house, Santa Barbara; at Barlow's ranch and the old irrigating ditch, Ventura; and at Twenty-sixth Street and Pacific Beach, San Diego. Much rarer than var. *carinata*. The specimen figured is from the upper San Pedro series at San Pedro, and is now in the collection of Delos Arnold.

*Living.*—Alaska to San Diego (Cooper).

*Pleistocene.*—Santa Barbara to San Diego (Cooper): San Pedro; Ventura; Santa Barbara; San Diego (Arnold).

*Pliocene.*—Kirker's Pass (Cooper).

### 233. Columbella (Astyris) gausapata *Gould*, var. carinata *Hinds*.

PLATE X, FIG. 10.

*Columbella carinata* HDS., Voyage Sulphur, p. 39, Pl. X, figs. 15, 16, 1844. CPR., Brit. Assn. Rept., 1863, p. 662. TRYON, Man. Conch., Vol. V, p. 116, Pl. XLVII, figs. 35–39, 1883. WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 213.
*Amycla carinata* HDS., GABB, Pal. Cal., Vol. II, p. 76, 1869.
*Astyris gausapata* var. *carinata* HDS., KEEP, West Coast Shells, p. 35, 1892.

Shell like *A. gausapata*, except that it has a distinct keel on the upper part of the whorl. A large series of shells shows mutations between the typical *gausapata* and this variety. An extreme keeled form gives the following dimensions: Long. 8 mm.; lat. 4.1 mm.; body-whorl 5 mm.; aperture 3.5 mm.

Common in all of the formations at all of the localities in the vicinity of San Pedro; much commoner than *C. gausapata*. Found also in the Pleistocene at the old irrigating ditch north of Ventura; at bath-house, Santa Barbara; and at Spanish Bight, San Diego.

The specimen figured is from the upper San Pedro series at San Pedro, and is now in the collection of Delos Arnold.

*Living.*—Santa Barbara to San Diego (Cooper).

*Pleistocene.*—Santa Barbara to San Pedro (Cooper): San Pedro; Ventura; Santa Barbara; San Diego (Arnold).

### 234. Columbella (Astyris) tuberosa *Carpenter*.

PLATE X, FIG. 7.

*Amycla tuberosa* CPR., Brit. Assn. Rept., 1863, p. 662; Ann. & Mag. Nat. Hist., 3rd Ser., Vol. XV, 1865, p. 398. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 229.
*Astyris tuberosa* CPR., STEARNS, Proc. Cal. Acad. Sci., Vol. V, 1873, p. 81. KEEP, West Coast Shells, p. 36, 1892.
*Columbella tuberosa* CPR., TRYON, Man. Conch., Vol. V, p. 135, Pl. L, figs. 40 and 41, 1883.
*Columbella (Astyris) tuberosa* CPR., WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 213, Pl. XX, fig. 6.

Shell small, slender; spire elevated; acute apex; whorls seven, only slightly convex; body-whorl angulated, lower portion decidedly concave and ornamented with narrow grooves and ridges; surface of upper whorls smooth except for delicate incremental lines; suture distinct; aperture ovate, and less than one-half the length of shell; anterior end of columella slender; outer lip thickened by row of tubercles on inner side; inner lip smooth; canal short, straight.

*Dimensions.*—Long. 6.5 mm.; lat. 2.8 mm.; body-whorl 4 mm.; aperture 2.9 mm.; defl. 22 degrees.

Distinguishable from other members of genus by slender spire and angulated body-whorl.

Rare in the lower San Pedro series at Deadman Island and San Pedro; and in the upper San Pedro series at Crawfish George's, Los Cerritos, San Pedro, and Deadman Island. Found also in the Pleistocene at Spanish Bight, San Diego;

and at bath-house, Santa Barbara. The specimen figured is from the upper San Pedro series at San Pedro, and is now in the collection of Delos Arnold.

*Living.*—Neah Bay to San Diego (Cooper).

*Pleistocene.*—Santa Barbara to San Pedro (Cooper): San Pedro; San Diego; Santa Barbara (Arnold).

*Pliocene.*—San Diego well (Dall).

### Genus **Amphissa** *H. & A. Adams.*

Shell bucciniform, longitudinally ribbed; spire elevated; aperture rather wide, enlarging below, and terminating in a wide anterior sinus; inner lip callous, plicate below; outer lip not thickened on margin, plicate within.

*Amphissa corrugata* Reeve is a characteristic species.

### 235. **Amphissa corrugata** *Reeve.*

*Buccinum corrugatum* RVE., Icon. Conch., Pl. IV, fig. 110, 1846.
*Truncaria corrugata* RVE., CPR., Brit. Assn. Rept., 1863, p. 662.
*Cominella (Amphissa) corrugata* RVE., CPR., Brit. Assn. Rept., 1866. GABB, Pal. Cal., Vol. II, p. 74, 1869.
*Amphissa corrugata* RVE., TRYON, Man. Conch., Vol. V, p. 197, Pl. LXIII, fig. 66, 1883. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 228. KEEP, West Coast Shells, p. 34, fig. 14, 1892.

Shell small, solid, fusiform; spire elevated; apex acute; whorls seven, slightly convex, with about eighteen to twenty rather wavy, slightly oblique, rounded, transverse ridges extending from suture to suture; spiral ornamentation consists of numerous fine, raised lines in the interspaces between the transverse ridges; suture impressed, distinct; aperture rhomboidal, narrow; outer lip lirate within; inner lip incrusted, smooth; canal short, recurved; pillar spirally lined externally.

*Dimensions.*—Long. 19 mm.; lat. 9 mm.; body-whorl 13.5 mm.; aperture 10 mm.; defl. 52 degrees.

The Pliocene forms are much smaller than the one described above (a Pleistocene specimen). Carpenter mentions the shells as becoming dwarfed in deep water (40 fathoms).

Rather common in Pliocene and lower San Pedro series at Deadman Island; rare in upper San Pedro series at San Pedro, Los Cerritos, and Crawfish George's. Found also in the Pleistocene at the bath-house, Santa Barbara.

*Living.*—Alaska to San Diego (Cooper).

*Pleistocene.*—Santa Barbara to San Diego (Cooper): San Pedro; Santa Barbara (Arnold).

*Pliocene.*—San Diego well (Dall): San Pedro (Arnold).

### 236. Amphissa ventricosa, sp. nov.

PLATE V, FIG. 11.

Shell small, broadly fusiform; spire elevated; whorls five or six, evenly convex, with twelve or thirteen strong, rounded, transverse ridges; interspaces sculptured with prominent, regular, equidistant, raised spiral lines, of which there are five or six on the penultimate whorl; suture deeply impressed, distinct; aperture semicircular; outer lip ventricose, thickened with row of teeth; inner lip smooth, incrusted; pillar straight; spirally sculptured on outside; no canal.

*Dimensions.*—Long. 12 mm.; lat. 6 mm.; body-whorl 8.6 mm.; aperture 6 mm.; defl. 43 degrees.

Resembles *A. bicolor* somewhat, but distinguishable from this species by lack of canal, stronger ribs, and more convex whorls; distinguishable from other members of genus by thin shell, ventricose whorls, semicircular aperture and lack of differentiated canal. Dr. Dall examined the type and pronounced it a new species.

Rare in lower San Pedro series of Deadman Island. The specimen figured is the type, which is from the lower San Pedro series at Deadman Island, and is now in the United States National Museum.

*Pleistocene.*—San Pedro (Arnold).

### 237. Amphissa versicolor *Dall.*

*Amphissa versicolor* DALL, Am. Jour. Conch., Vol. VII, 1872, p. 111. TRYON, Man. Conch., Vol. V, p. 197, Pl. LXIII, fig. 67, 1883; Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 213, Pl. XX, fig. 9.

*Amphissa corrugata* RVE., COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 228 (in part).

Shell small, fusiform; apex acute; whorls seven, convex, slightly angular above; body-whorl slightly ventricose; surface ornamented with about fourteen rounded, obliquely transverse ridges, and several distinct, raised, spiral lines in the interspaces; suture quite deeply impressed; aperture subelliptical; outer lip slightly thickened by lirated ridges on inner side; inner lip incrusted, smooth; columella spirally sculptured externally; canal short, broad, recurved.

*Dimensions.*—Long. 10.2 mm.; lat. 5 mm.; body-whorl 7 mm.; aperture 5 mm.; defl. 47 degrees.

Distinguishable from *A. corrugata* by more ventricose body-whorl, relatively longer columella and shorter spire, more angulated whorls, deeper suture and less numerous but more oblique and larger transverse ridges. Specimen identified by Dr. Dall.

Found in lower San Pedro series at Deadman Island, and upper San Pedro series at Crawfish George's, Los Cerritos, and Deadman Island. Found also in the Pleistocene at Pacific Beach, San Diego.

*Living.*—San Pedro (Dall).

*Pleistocene.*—San Pedro; San Diego (Arnold).

## Family LXI. MURICIDÆ.

### Genus **Murex** *Linné.*

Shell ovate or oblong; spire prominent; whorls convex, crossed by three or more continuous varices; aperture ending below in a canal, which is generally partly closed.

*Murex tenuispena* Lam. is a characteristic species.

### Subgenus **Chicoreus** *Montfort.*

Shell ovate-pyriform; varices foliated and sometimes spinose; canal short, curved, wide, nearly closed.

*Murex adustus* Lam. is a characteristic species.

#### 238. **Murex (Chicoreus) leeanus** *Dall.*

PLATE VII, FIG. 1.

*Murex (Chicoreus) leeanus* DALL, Proc. U. S. Nat. Mus., Vol. XII, 1890, p. 329, Pl. VII, fig. 1.

Shell large, strong, angular in outline; apex sharp; whorls five or six, angular, flat to concave above; each whorl ornamented with three varices, which extend out into long, rather sharp spines; the varices toward the apex fall short of completing a whole whorl, so that they are slightly spirally arranged; a faint node on angle between each pair of varices; surface sculptured with delicate squamose, spiral cinguli, with chiseled grooves between; suture deeply impressed, wavy; aperture elliptical; outer lip smooth; inner lip slightly projecting, smooth; canal long, narrow, slightly curved, covered; older termini of canal visible on pillar at left of canal.

*Dimensions.*—Long. 55 mm.; lat. 43 mm.; body-whorl 47 mm.; aperture 17 mm.

A large, showy shell, easily distinguishable by the long, sharp varical spines. Specimens identified by Dr. Dall.

Rare in upper San Pedro series at San Pedro and Crawfish George's. The drawing of this species is a composite, and was made from two imperfect specimens from the upper San Pedro series at San Pedro, which are now in the collection of Delos Arnold.

*Living.*—Cerros Island, off Lower California (Dall).

*Pleistocene.*—San Pedro (Arnold).

#### 239. **Murex (Chicoreus?) trialatus** *Sowerby.*

*Murex trialatus* SBY., Proc. Zool. Soc., 1840, p. 143. TRYON, Man. Conch., Vol. II, p. 113, Pl. XXXIV, fig. 372, 1880.

*Murex californicus* HDS., Proc. Zool. Soc., 1843, p. 128. Voyage Sulphur, Pl. III, figs. 9 and 10, 1844. TRYON, Man. Conch., Vol. II, p. 113, Pl. XXXIV, fig. 375; Pl. XXXV, fig. 287, 1880.

*Muricidea californica* HDS., CPR., Brit. Assn. Rept., 1863, p. 663. GABB, Pal. Cal., Vol. II, p. 69, 1869.

Shell small, fusiform; spire elevated, subacute; whorls five, convex; body-whorl over three-fourths length of shell; varices three, thick and rounded, elevated on angle of whorl to sharp,

prominent nodes; a single, less prominent, rounded node on angle between each pair of varices; spiral sculpture of fine raised lines, with fine incremental lirulæ in the interspaces; aperture ovate; canal long, narrow, slightly recurved, and generally covered by overgrowing sides; lower part of columella slightly widened; outer lip thickened by varix, smooth inner surface; inner lip slightly raised and smoothly enameled.

*Dimensions.*—Long. 38 mm.; lat. 21.5 mm.; body-whorl 30 mm.; aperture 22.5 mm.; canal 11 mm.; defl. 60 degrees.

Rare in upper San Pedro series at San Pedro, Deadman Island, and Crawfish George's.

*Living.*—Baulinas Bay to San Diego (Carpenter): Lower California (Hemphill).

*Pleistocene.*—San Pedro (Arnold).

### Subgenus **Pteronotus** *Swainson.*

Shell triangular; varices fin-like or foliated; canal moderate, closed, somewhat curved.

*Murex trigonulus* Lam. is a characteristic species.

### 240. Murex (Pteronotus) festivus *Hinds.*

*Murex festivus* Hds., Proc. Zool. Soc., 1843, p. 127; Voyage Sulphur, p. 9, Pl. III, figs. 13 and 14, 1844. Tryon, Man. Conch., Vol. II, p. 116, Pl. XXXV, fig. 383, 1880.

*Pteronotus festivus* Hds., Cpr., Brit. Assn. Rept., 1863, p. 663. Gabb, Pal. Cal., Vol. II, p. 70. 1869. Cooper, 7th Ann. Rept. Cal. St. Min., 1888, p. 261. Dall, Trans. Wagner Inst. Sci., Vol. III, Part I, 1890, p. 142. Keep, West Coast Shells, p. 22, fig. 3, 1892. Williamson, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 216.

Shell of moderate size, fusiform; spire elevated, short; whorls six, subangulate, crossed by three prominent, reflexed, frill-like varices; a single rounded node between each set of varices; numerous spiral lines, which are almost obsolete, ornament the intervarical spaces; suture deeply impressed; aperture pyriform; outer and inner lips smooth; canal long, narrow, slightly curved; columella squamose on outside, widened slightly.

*Dimensions.*—Long. 40 mm.; lat. 21 mm.; body-whorl 31 mm.; aperture, not including canal, 12 mm.; canal 11 mm.; defl. 65 degrees.

This species is characterized by the sharp, frill-like varices said by Dr. Dall to resemble quite closely *P. textilis* Gabb, of the Miocene of San Domingo and Hayti, and the Pliocene of Florida.

Rare in the lower San Pedro series at Deadman Island; not uncommon in the upper San Pedro series at Deadman Island, Crawfish George's, San Pedro and Los Cerritos. Found also in the Pleistocene at Spanish Bight, San Diego.

*Living.*—San Pedro to San Diego; Lower California (Cooper).

*Pleistocene.*—Santa Barbara; San Diego (Cooper): San Pedro; San Diego (Arnold).

### Subgenus **Pterorhytis** *Conrad.*

Varices wing-like; aperture usually dentate within the outer lip, with a produced tooth near its base.

Type, *Murex nuttalli* Conrad.

### 241. Murex (Pterorhytis) foliatus *Martyn*.

*Cerostoma foliatum* MARTYN, Univ. Conch., No. 66, Pl. XXIV, fig. 1, 1784. CPR., Brit. Assn. Rept., 1863, p. 663. KEEP, Common Sea Shells, Pl. XIV, fig. 5, 1881; West Coast Shells, p. 27, 1892.
*Murex foliatus* MART., TRYON, Man. Conch., Vol. II, p. 113, Pl. XXXIV, figs. 370, 371, 373, 1880.
*Pterorhytis foliatus* MART., COOPER, Bull. No. 4, Cal. St. Min. Bureau, Part 3, 1894, p. 24.

Shell small, broadly fusiform, with extended varices; spire elevated, subacute; whorls three to four; varices three, widely expanded, foliated on anterior side; one prominent node on convex surface of whorl between each set of varices; aperture subovate, with smooth outer and inner lip; canal long, narrow, expanding anteriorly, generally covered by overgrowing lips.

*Dimensions.*—Long. 35 mm.; lat. 21 mm.; body-whorl 26.5 mm.; aperture 21 mm.; canal 10 mm.

Distinguishable by the wing-like, foliated varices. The specimen described was too poor to figure.

Rare in the upper San Pedro series of San Pedro; one specimen found.

*Living.*—Vancouver to Oregon (Carpenter): Sitka to Santa Barbara; Asia (Cooper).

*Pleistocene.*—San Pedro (Arnold): Puget Sound; San Diego; Santa Barbara Islands (Carpenter): San Joaquin Bay, Orange County (Bowers).

### 242. Murex (Pterorhytis) nuttalli *Conrad*.

*Cerostoma nuttalli* CON., Jour. Phil. Acad. Nat. Sci., Vol. VII, 1837, p. 264, Pl. XX, fig. 22. CPR., Proc. Zool. Soc., 1856, p. 229; Brit. Assn. Rept., 1863, p. 663. TRYON, Struct. and Syst. Conch., Vol. II, p. 105, Pl. XLIII, fig. 8, 1883. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 233. KEEP, West Coast Shells, p. 26, fig. 8, 1892.
*Pterorhytis nuttalli* CON., WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 215.

Shell of medium size, heavy, thick; spire elevated, subacute; whorls four, convex, each with three prominent varices, which are rather smooth behind, but showing their lamellar structure in front; each varix is connected with the analogous varix on the preceding whorl, but the varices being slightly less than one-third of a revolution apart cause the radiating ridges formed by the connected varices to be spirally twisted; intervarical spaces prominently spirally ribbed, the ribs extending on to the backs of the varices; seven or eight prominent spiral ribs on the body-whorls; aperture elliptical; outer lip with eight or nine internal teeth, each corresponding to one of the external sulcations of the body-whorl; sometimes with prominent tooth near anterior portion of outer lip; inner lip smooth; canal rather short, covered; lower portion of columella expanded, rough, subpunctate.

*Dimensions.*—Long. 65 mm.; lat. 34 mm.; body-whorl 50 mm.; aperture 25 mm.; canal 14 mm.

This species may be only a variety of *P. foliatus* Mart. It is distinguishable from the latter species by the greater prominence of its spiral sculpture, and its lower varices.

Rare in upper San Pedro series at Deadman Island and Los Cerritos.

*Living.*—Baulinas Bay to San Diego (Cooper).

*Pleistocene.*—San Pedro (Arnold): San Diego (Cooper).

### 243. Murex (Pterorhytis) monoceros *Sowerby.*

*Murex monoceros* SBY., Proc. Zool. Soc., 1840, p. 143. TRYON, Man. Conch., Vol. II, p. 115, Pl. XXXV, figs. 388, 389, 1880.

*Muricidea (Phyllonotus) paucivaricata* GABB, Pal. Cal., Vol. II, p. 43, Pl. XIV, fig. 1, 1869 (*fide* TRYON).

*Muricidea paucivaricata* GABB, COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 252 (*fide* TRYON).

Shell moderate in size, fusiform; spire nearly as long as aperture; whorls seven, subangulated, bearing eight or nine large, longitudinal ribs which develop into prominent nodes on the angle; suture irregular, appressed, distinct; aperture ovate; canal rather short, narrow, recurved, and often overgrown by two lips; outer lip thickened, denticulated with four sharp teeth; inner lip slightly projecting, smooth, incrusted; columella widened; varices two or three, never prominent, sometimes obsolete; numerous small revolving ribs crossed by small squamose plates; body-whorl sometimes ornamented with five or six, quite prominent, rounded, spiral ridges.

*Dimensions.*—Long. 46 mm.; lat. 23 mm.; body-whorl 32 mm.; aperture, including canal, 26 mm.; canal 9 mm.; defl. 50 degrees.

Distinguishable from *M. californica* by denticulated outer lip, lack of varices, thicker shell, and generally larger size. Originally described from Pleistocene specimen.

Rare in upper San Pedro series of San Pedro.

*Living.*—Lower California?

*Pleistocene.*—Santa Barbara; San Diego (Cooper): San Pedro (Arnold).

## Genus **Monoceros** *Lamarck.*

Shell ovate; last whorl large; spire rather elevated; aperture semilunar; inner lip wide and flattened; outer lip crenated, with a prominent tooth usually at the forepart.

*Monoceros lugubre* Sowb. is a characteristic species.

### 244. Monoceros engonatum *Conrad.*

*Monoceros engonatum* CON., Jour. Phil. Acad. Nat. Sci., Vol. VII, 1837, p. 264, Pl. XX, fig. 17. CPR., Brit. Assn. Rept., 1863, p. 663. GABB, Pal. Cal., Vol. II, p. 75, 1869. TRYON, Man. Conch., Vol. II, p. 195, Pl. LXI, figs. 304, 1880. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 251. KEEP, West Coast Shells, p. 29, fig. 10, 1892. WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 214.

*Monoceros unicarinatum* RVE., Icon. Conch., Sp. 1.

Shell of medium size, fusiform; whorls six, angular, flattened to concave above and below; spirally sulcate, sulci with tranverse lamellar striæ; suture deeply appressed, distinct; aperture subelliptical; outer lip effuse, dentate within; inner lip slightly flattened, smooth; canal deep, narrow, recurved; pillar twisted, squamose.

*Dimensions.*—Long. 40 mm.; lat. 20 mm.; body-whorl, 30.5 mm.; aperture 24 mm.; defl. 55 degrees.

This is a variable species. Specimens showing the scaly surface of var. *spiratum* grade over into the smooth form; the sharp-keeled forms merge into those which approach very near to *M. lapilloides.* Some specimens have thin and smooth

outer lips, while others are strongly dentate. Of fifty specimens from the San Pedro Pleistocene only three have the characteristic tooth developed, thus showing that in these earlier forms this distinguishing characteristic was only occasional. The scaly specimens are generally the strongest keeled. This latter form is the var. *spiratum* of Blainville.

Found in all of the lower and upper San Pedro series localities in the vicinity of San Pedro. Found also in the Pleistocene at Barlow's ranch, Ventura; and at Pacific Beach, San Diego.

*Living.*—Baulinas Bay to San Diego (Cooper).

*Pleistocene.*—San Pedro; San Diego (Cooper): Lake Merced, San Mateo County; San Pedro; San Diego; Ventura (Arnold).

### 245. **Monoceros lapilloides** *Conrad.*

*Purpura* (*Monoceros*) *lapilloides* CON., Jour. Phil. Acad. Nat. Sci., Vol. VII, 1837, p. 265, Pl. XX, fig. 18.

*Monoceros lapilloides* CON., = *M. punctatum* GRAY, + *M. brevidens* CON. (*fide* CPR., Brit. Assn. Rept., 1863, p. 663). KEEP, West Coast Shells, p. 28, fig. 9, 1892. COOPER, Bull. No. 4, Cal. St. Min. Bureau, 1894, Part 3, p. 28.

Shell of medium size, purpuroid-shaped; spire elevated; apex subacute; whorls four, very slightly convex; surface ornamented with nearly obsolete spiral cinguli and nearly obsolete, irregular, wavy, transverse ridges; suture impressed, indistinct; aperture subovate; outer lip thickened, dentate; inner lip flattened, smooth; canal short.

*Dimensions.*—Long. 20.5 mm.; lat. 13 mm.; body-whorl 18 mm.; aperture 14 mm.; defl. 67 degrees.

The specimen described shows the reddish color of the live shells. Distinguishable from *M. engonatum* by much shorter spire, broader and shorter pillar, and much less angular whorls; distinguishable from *Purpura saxicola* by relatively larger spire, narrower aperture, dentate outer lip and spiral cinguli.

Rare in upper San Pedro series of San Pedro; one specimen.

*Living.*—Santa Barbara to San Diego (Carpenter): Monterey (Cooper).

*Pleistocene.*—San Pedro (Arnold): Ventura County (Bowers).

## Genus **Chorus** *Gray.*

Shell laminately varicose; spinose on the shoulder; canal rather long; outer lip with a spine as in *Monoceros*.

Type, *Chorus belcheri* Hinds.

### 246. **Chorus belcheri** *Hinds.*

*Murex belcheri* HDS., Proc. Zool. Soc., 1843, p. 127; Voyage Sulphur, Pl. II, figs. 1–3, 1844. PFEIFFER, Nov. Conch., Ser. II, p. 35, Pl. X, figs. 6, 7.

*Chorus belcheri* HDS., CPR., Brit. Assn. Rept., 1863, p. 663. TRYON, Man. Conch., Vol. II, p. 198, Pl. LXI, fig. 309, 1880; Syst. Conch., Vol. II, p. 114, Pl. XLV, figs. 43, 44, 1883. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 235. KEEP, West Coast Shells, p. 25, fig. 7, 1892. WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 216.

Shell large, broadly fusiform; spire slightly elevated; whorls five, sharply angulated, with eight or nine nearly obsolete varices which rise to prominent blunt nodes or spines on the angle of whorl; incremental lines prominent; spiral liration on upper whorls; suture impressed, distinct; aperture ovate; outer lip not thickened, effuse; inner lip incrusted; columella widened; umbilicus perforate; canal long, narrow, curved backwards.

*Dimensions.*—Long. 90 mm.; lat. 62 mm.; body-whorl 78 mm.; aperture 40 mm.; canal 25 mm.; defl. 95 degrees.

A beautiful shell, one of the largest gastropods found in this formation.

Rare in upper San Pedro series at Crawfish George's, Los Cerritos, and San Pedro. Found also in the Pleistocene at Barlow's ranch, Ventura.

*Living.*—Catalina Island to San Diego; Lower California (Cooper): Sitka (Carpenter): Japan (Tryon).

*Pleistocene.*—San Pedro (Cooper; Arnold): Ventura (Arnold).

*Pliocene.*—San Diego well (Dall).

### Genus **Eupleura** *H. & A. Adams.*

Shell ranelliform, with a pair of lateral varices, one on either side, and intermediate smaller varices; aperture dentate within.

*Eupleura caudata* Say is a characteristic species.

### 247. **Eupleura muriciformis** *Broderip.*

PLATE IX, FIG. 16.

*Ranella muriciformis* BROD., Proc. Zool. Soc., 1832, p. 179. RVE., Conch. Icon., *Ranella*, Pl. VII, fig. 34, 1844.

*Ranella plicata* RVE., Proc. Zool. Soc., 1844, p. 138; Conch. Icon., *Ranella*, Pl. VII, fig. 33, 1844.

*Ranella triquetra* RVE., Proc. Zool. Soc., 1844, p. 139; Conch. Icon., *Ranella*, Pl. VII, fig. 41, 1844. CPR., Brit. Assn. Rept., 1863, p. 667; 1856, p. 201. GABB, Pal., Vol. II, p. 73, 1869. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 262.

*Eupleura muriciformis* BROD., CPR., Brit. Assn. Rept., 1856, p. 182. TRYON, Man. Conch., Vol. II, p. 168, Pl. XXXIX, figs. 501, 502, 504, 505, 1880. DALL, Trans. Wagner Inst. Sci., Vol. III, Part I, 1890, p. 145.

*Eupleura muriciformis* (var.?) *unispinosa* DALL, Proc. U. S. Nat. Mus., Vol. XIV, 1891, p. 174, Pl. VI, fig. 5.

Shell of medium size, quite broadly fusiform, solid; spire elevated; whorls five, subangular at lower one-third, concave to straight above, convex below; whorls crossed by varices at every two-thirds revolution, the two varices on the body-whorl and the next varix posterior to these are prominent, the others being obsolete in most cases; the varices are generally thin, webbed, and with six obsolete spines; the spine at the shoulder is the most prominent, but the second spine, counting forward, is the one corresponding to the axis of the intervarical nodes; the web between the shoulder spine and the suture is bent forward; spiral ridges correspond to each spine; four nodes on angle of whorl between each pair of varices; suture deeply impressed, distinct; aperture elliptical; outer lip thickened by six dentiform calluses, one each between each pair of external spiral ridges; canal long, narrow, nearly straight.

*Dimensions.*—Long. 25.5 mm.; lat. 14 mm.; body-whorl 20.5 mm.; aperture, including canal, 17.5 mm.; canal 7 mm.; defl. 70 degrees.

The prevailing type of the San Pedro fossil specimens does not correspond exactly to any of the descriptions of the living varieties of this species as given by Dr. Dall in the paper cited above. It comes nearest to var. *unispinosa*, differing from that form by having a straight canal. The name var. *pleistocenensis* is suggested for the San Pedro fossil form.

Rare in the upper San Pedro series of San Pedro; one specimen from lower San Pedro series at Deadman Island. Found also in the Pleistocene at Twenty-sixth Street, San Diego. The specimen figured is from the upper San Pedro series at San Pedro, and is now in the collection of Delos Arnold.

*Living.*—California to Venezuela (Dall).

*Pleistocene.*—San Pedro (Arnold): San Diego (Dall; Cooper; Arnold): Pacific coast of Lower California; head of the Gulf of California (Dall).

### 248. **Eupleura muriciformis** var. **curta**, var. nov.

PLATE VIII, FIG. 9.

Shell small, broadly fusiform; whorls four, angular, flat above, convex below; two sharp spiral ridges on upper whorls, six on body-whorl corresponding to obsolete spines on varix; one prominent varix on body-whorl, other varices obsolete; whorls crossed by prominent, narrow, rounded ridges, of which there are twelve on the penultimate whorl; aperture elliptical; outer lip thickened by a row of six denticles; inner lip smooth, projecting; canal short, narrow.

*Dimensions.*—Long. 15 mm.; lat. 10 mm.; body-whorl 11 mm.; aperture, including canal, 9.5 mm.; canal 2.2 mm.; defl. 65 degrees.

Differs from *E. muriciformis* in having obsolete varices, transverse ridges instead of nodes, much shorter canal, and in general much stronger sculpture.

The type, which is figured, is from the upper San Pedro series at San Pedro, and is now in the United States National Museum.

*Pleistocene.*—San Pedro (Arnold).

## Genus **Trophon** *Montfort.*

Varices numerous, lamelliform or laciniated; spire prominent; aperture ovate; canal open, usually turned to the left; shell white, often dark colored within the aperture.

*Trophon clathratus* Linn. is a characteristic species.

## Subgenus **Boreotrophon** *Fischer.*

### 249. **Trophon (Boreotrophon) cerritensis**, sp. nov.

PLATE VI, FIG. 6.

Shell of medium size, elongate-fusiform, heavy; whorls six, angular, with angle in middle, crossed by about eighteen strong, transverse ribs; lower portion of whorls ornamented with two or three strong, spiral ridges, one of which is on the angle, the two systems of ridges giving a cancellated surface; body-whorl and columella cancellated; suture deeply impressed, distinct; aperture

elliptical; outer lip thickened, smooth within; inner lip incrusted, smooth; columella only faintly squamose, curved and slightly twisted; canal rather short, narrow.

*Dimensions.*—Long. 33 mm.; lat. 15 mm.; body-whorl 23 mm.; aperture, including canal, 18 mm.; canal 7 mm.; defl. 44 degrees.

The largest of the *Trophons* so far found in this locality. The adult of this shell resembles var. *præcursor*, but is distinguishable from that species by its larger size, heavier shell, more prominent spiral ridges, proportionally shorter canal, and in having the angle near the middle of the whorl, rather than posterior to the middle; distinguishable from *T. stuarti* by heavier shell, more numerous and much heavier, lower and more rounded, transverse ridges, shorter canal, and by having the angle in the middle of the whorl. The young of *T. cerritensis* resembles *T. pedroana* somewhat, but may be distinguished from that species by its heavier shell, more depressed outline and much shorter canal. An adult found at Los Cerritos has fewer transverse ridges and a higher angle than the type. Type from lower San Pedro series of Deadman Island. Said by Dr. Dall to be near *T. craticulatus* Fabricius.

One adult specimen (type) and five juniors found in lower San Pedro series at Deadman Island; one specimen from Los Cerritos in upper San Pedro series. The specimen figured is the type, which is from the lower San Pedro series at Deadman Island, and is now in the United States National Museum.

*Pleistocene.*—San Pedro (Arnold).

### 250. Trophon (Boreotrophon) gracilis *Perry.*

PLATE VI, FIG. 8.

*Polyplex gracilis* PERRY, Conch., Pl. IX, fig. 4.

*Trophon multicostatus* (not of ESCH.) GABB, Pal. Cal., Vol. II, p. 70, 1869 (in part). COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 268 (in part).

Shell of medium size, fusiform; spire elevated; whorls five or six, sharply angular, crossed by eight or nine frill-like varices, which flex forward and are only slightly coronate on angle; surface smooth; suture deeply impressed, giving tabulate appearance to upper part of whorl; aperture elliptical; outer lip effuse, smooth within; inner lip smooth; columella long, slightly twisted; canal long, narrow, recurved.

*Dimensions.*—Long. 26 mm.; lat. 13 mm.; body-whorl 19 5 mm.; aperture 16.2 mm.; canal 7.7 mm.; defl. 62 degrees.

Distinguishable by frill-like varices and lack of spiral sculpture. Specimens identified by Dr. Dall. This species is the *T. multicostatus* of most western collectors. It differs from that species in having fewer, but more prominent varices, and in being a broader shell.

Rare in Pliocene and lower San Pedro series of Deadman Island. Found also in the Pleistocene at bath-house, Santa Barbara. The specimen figured is from the Pliocene of Deadman Island, and is now in the collection of Delos Arnold.

*Living.*—Circumpolar; Sitka to Monterey (Cooper).

*Pleistocene.*—Santa Barbara (Cooper; Arnold): San Pedro (Arnold).

*Pliocene.*—San Pedro (Arnold).

### 251. Trophon (Boreotrophon) multicostatus *Eschscholtz*.

PLATE VI, FIG. 9.

*Murex multicostatus* ESCH., Zool. Atlas, Vol. II, p. 11, Pl. IX, fig. 4, 1829. KUSTER, *Murex*, p. 45, Pl. XVIII, figs. 5 and 6, 1837.

*Trophon multicostatus* ESCH., H. & A. ADAMS, Gen. Rec. Moll., Vol. 1, p. 77. CPR., Brit. Assn. Rept., 1863, p. 663 (in part). TRYON, Man. Conch., Vol. II, p. 141, Pl. XXXI, fig. 316, 1880. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 269 (in part). KEEP, West Coast Shells, p. 21, 1892 (in part).

Shell small, fusiform; whorls five, angular above, with twelve to fourteen raised varices; no spiral sculpture; aperture subelliptical; outer lip not effuse; inner lip smooth; canal short, slightly curved.

*Dimensions.*—Long. 10.5 mm.; lat. 4.5 mm.; body-whorl 7 mm.; aperture, including canal, 5 mm.; canal 1 mm.; defl. 40 degrees.

The shell described is a small one. Distinguishable from *T. gracilis* by having larger number of varices, less prominent varices, more slender shell, a less effuse outer lip, and less sharply angulated whorls. Identified as "*T. multicostatus* var.?" by Dr. Dall.

Rare in the lower San Pedro series at Deadman Island, and in upper San Pedro series at San Pedro. The specimen figured is from the lower San Pedro series at Deadman Island, and is now in the collection of Delos Arnold.

*Living.*—Sitka to Monterey; circumpolar (Cooper).

*Pleistocene.*—Santa Barbara (Cooper): San Pedro (Arnold).

### 252. Trophon (Boreotrophon) pedroana, sp. nov.

PLATE VI, FIG. 12.

Shell small, elongate-fusiform, thin; spire elevated, acute; whorls six, convex, with very slight angle about one-third width from posterior margin; body-whorl slightly ventricose; whorls ornamented with about fourteen slightly raised, rounded transverse ridges, and two faint spiral ridges, one of which is on the angle of whorl; suture deeply impressed, distinct; aperture semiovate; outer lip thin, not effuse; inner lip smooth; columella long and slender, smooth; canal long, narrow, nearly straight.

*Dimensions.*—Long. 12 mm.; lat. 4.8 mm.; body-whorl 9 mm.; aperture, including canal, 7 mm.; canal 3 mm.; defl. 35 degrees.

The thinnest, most delicate of the *Trophons* of this locality. Distinguishable from var. *præcursor* by thinness, less angulation of whorls, less prominence of sculpture, and simple outer lip; distinguishable from *T. scalariformis* by its thinness, narrowness, and spiral lines; distinguishable from *T. disparilis* Dall by smaller size, more numerous whorls, and more prominent transverse sculpture.

Pronounced a new species by Dr. Dall, who also says that it is near *T. disparilis*, which has been dredged at Gray's Harbor, Alaska.

Rather common in the lower San Pedro series at San Pedro and Deadman Island; found also in upper San Pedro series at Crawfish George's. The specimen

figured is the type, which came from the lower San Pedro series at Deadman Island, and is now in the United States National Museum.

*Pleistocene.*—San Pedro (Arnold).

### 253. Trophon (Boreotrophon) scalariformis *Gould.*

PLATE VI, FIG. 10.

*Fusus scalariformis* GLD., Invert. Mass., p. 288, fig. 208.
*Trophon scalariformis* GLD., TRYON, Man. Conch., Vol. II, p. 141, Pl. XXXI, fig. 314, 1880.

Shell small, fusiform, spire elevated, subacute; whorls four or five, convex, crossed by about thirteen prominent rounded ribs, most prominent in middle of whorl; body-whorl ventricose; suture impressed, distinct; aperture broadly ovate; outer lip slightly effuse; inner lip curved, smooth; columella long, rather narrow, curved, smooth; canal of medium length, narrow.

*Dimensions.*—Long. 16 mm.; lat. 7.5 mm.; body-whorl 10.5 mm.; aperture, including canal, 8 mm.; canal 3 mm.; defl. 44 degrees.

Somewhat resembles *T. multicostatus*, but is distinguishable by lack of angulation in whorls, longer columella and canal, but rather more ventricose body-whorl; easily distinguishable from *T. pedroana* by more depressed aspect of shell and lack of spiral lines. Very faint spiral lines sometimes visible. Specimens identified by Dr. Dall.

Rather common in lower San Pedro series, rare in Pliocene of Deadman Island; found in the lower San Pedro series at San Pedro; and in the upper San Pedro series at Crawfish George's. The specimen figured is from the lower San Pedro series at Deadman Island, and is now in the collection of Delos Arnold.

*Living.*—Circumboreal. Gulf of St. Lawrence.

*Pleistocene.*—San Pedro (Arnold).

*Pliocene.*—San Pedro (Arnold).

### 254. Trophon (Boreotrophon) stuarti *Smith.*

PLATE VI, FIG. 4.

*Trophon stuarti* SMITH, Proc. Zool. Soc., 1880, p. 481, Pl. XLVIII, fig. 6.
*Trophon orpheus* GLD., CPR., Brit. Assn Rept., 1863, p. 663 (in part). TRYON, Man. Conch., Vol. II, p. 139, Pl. XXXI, fig. 310, 1880 (in part). COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 268 (in part). KEEP, West Coast Shells, p. 21, 1892 (in part).

Shell of medium size, fusiform; spire elevated, acute; whorls seven, sharply angular, crossed by nine to eleven frill-like varices which rise to sharp points on angle; whorls ornamented with two to three sharp, spiral ridges, one of which revolves on angle; aperture semielliptical; outer lip thickened, smooth within; inner lip incrusted, projecting; columella long, twisted, squamose; canal long, narrow, slightly curved.

*Dimensions.*—Long. 30 mm.; lat. 13 mm.; body-whorl 2 mm.; aperture, including canal 16.5 mm.; canal 8 mm.; defl. 52 degrees.

Distinguishable by prominent, frill-like varices and sharp spiral lines, which give latticed appearance. Specimens identified by Dr. Dall.

Rare in Pliocene of Deadman Island and Timm's Point; also reported from lower San Pedro series at Deadman Island. The specimen figured is from the Pliocene at Deadman Island, and is now in the collection of Delos Arnold.

*Living.*—Sitka to Straits of Fuca; Washington (Cooper).

*Pleistocene.*—San Pedro; San Diego (Cooper): San Pedro (Arnold).

*Pliocene.*—San Pedro (Arnold): San Diego well (Dall).

### 255. Trophon (Boreotrophon) stuarti *Smith* var. præcursor, var. nov.

PLATE VI, FIG. 5.

Shell small, elongate-fusiform; spire elevated, acute; whorls six or seven, angulated above, crossed by about fifteen sharp varices, and with two sharp spiral lines; suture deeply impressed, distinct; aperture subelliptical; outer lip effuse, smooth; inner lip smooth; columella long, straight, nearly smooth; canal long, narrow, very slightly curved.

*Dimensions.*—Long. 15 mm.; lat. 5.5 mm.; body-whorl 10 mm.; aperture, including canal, 8 mm.; canal 4.2 mm.; defl. 35 degrees.

Distinguishable from *T. stuarti* by smaller size, less prominent transverse frills and spiral lines, and slenderer form; distinguishable from *T. disparilis* by much more sharply defined sculpture and more angulated whorls. Pronounced var. *præcursor* of *T. stuarti* by Dr. Dall. Type from Pliocene of Deadman Island.

Not uncommon in Pliocene and lower San Pedro series of Deadman Island. Found also in Pleistocene at bath-house, Santa Barbara. The specimen figured is the type, which was found in the Pliocene of Deadman Island, and is now in the collection of Delos Arnold.

*Pleistocene.*—San Pedro (Arnold).

*Pliocene.*—San Pedro; Santa Barbara (Arnold).

### 256. Trophon (Boreotrophon) tenuisculptus *Carpenter.*

*Trophon tenuisculptus* CPR., Ann. & Mag. Nat. Hist., 3rd Ser., Vol. XVII, 1866, p. 277. GABB, Pal. Cal., Vol. II, p. 70, 1869. TRYON, Man. Conch., Vol. II, p. 139, Pl. XXXIII, fig. 359, 1880. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 268.

Shell small, fusiform; whorls five, angulated above, forming a slightly sloping, tabular band above; ornamentations of numerous transverse ridges and several spiral lines; suture deeply impressed; aperture elliptical; outer lip thin; inner lip incrusted, smooth; canal narrow; columella long, twisted.

*Dimensions of a Young Specimen.*—Long. 14.5 mm.; lat. 6.1 mm.; body-whorl 10 mm.; aperture and canal 8 mm.; canal 4.5 mm.; defl. 50 degrees.

Distinguishable by numerous transverse ridges, which are more numerous than in any other member of this genus found in this locality. Type of species from Pleistocene of Santa Barbara. Specimen identified by Dr. Dall.

Rare in Pliocene of San Pedro district.

*Pleistocene.*—Santa Barbara (Carpenter).

*Pliocene.*—San Pedro (Arnold).

### 257. Trophon (Boreotrophon) triangulatus *Carpenter.*

*Trophon triangulatus* CPR., Brit. Assn. Rept., 1863, p. 663; Proc. Cal. Acad. Sci., Vol. III, 1865, p. 224. TRYON, Man. Conch., Vol. II, p 42, 1880. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 268.

*Trophon (Boreotrophon) triangulatus* CPR., DALL, Proc. U. S. Nat. Mus., Vol. XIV, 1891, p. 180, Pl. V, figs. 1, 3 and 6; Vol. XV, 1892, p. 216.

"Whorls about seven, the nuclear lost; varices six to the whorl, strong, wide, thin-edged, with guttered spines which have their hinder edge rounded; surface with strongly marked lines of growth and half obsolete, fine, irregular, spiral scratches, strongest on the body and almost wholly wanting between the suture and the spines; the aperture in some specimens might be denticulate.

"*Dimensions.*—Long. 75 mm.; lat. 50 mm.; aperture 56 mm."

As the only shell found in the Pleistocene was an extremely young and worn specimen, the above, taken from a description by Dr. Dall (Proc. U. S. Nat. Mus., Vol. XIV, p. 180), is inserted. The Pleistocene specimen measures 9 mm. in length, and has nine varices. The young of this species is distinguishable from the young of *T. gracilis* by having a shorter canal and less prominent varices.

Rare in lower San Pedro series of Deadman Island.

*Living.*—Santa Cruz Island to Catalina; Lower California (Cooper): San Pedro (Williamson).

*Pleistocene.*—Santa Barbara (Cooper): San Pedro (Arnold).

## Genus **Ocinebra** *Leach.*

Shell small, with numerous varices which are foliated and often spinose; spiral sculpture; canal more or less closed.

*Ocinebra erinaceus* Linn. is a characteristic species.

### 258. Ocinebra barbarensis *Gabb.*

PLATE V, FIG. 1.

*Murex barbarensis* GABB, Proc. Cal. Acad. Sci., Vol. III, 1865, p. 183.
*Muricidea barbarensis* GABB, Pal. Cal., Vol. II, p. 69, 1869.
*Ocinebra barbarensis* GABB, TRYON, Man. Conch., Vol. II, p. 124, 1880.

Shell small, fusiform; spire elevated, subacute; whorls four or five, sharply angulated, flat or concave above, slightly convex below, ornamented with five to nine rather sharp, transverse ridges, which rise to a sharp, recurved process on angle, and by numerous strong, squamose, revolving ridges; suture very deeply appressed, giving spire a staircase appearance; aperture subelliptical; outer lip thickened, denticulated; inner lip incrusted, projecting slightly; canal short, narrow, generally covered; columella slightly widened and twisted.

*Dimensions.*—Long. 19 mm.; lat. 10 mm.; body-whorl 15 mm.; aperture, including canal, 11 mm.; canal 5 mm.; defl. 60 degrees.

Distinguishable from *O. perita* by more prominent processes on angle of whorl, more prominent spiral ridges, deeper appressed suture, and more tabulated upper portion of whorl. Specimens identified by Dr. Dall.

Rare in the lower San Pedro series at San Pedro and Deadman Island. Found also in the Pleistocene at Santa Barbara. The specimen figured is from the lower San Pedro series at Deadman Island, and is now in the collection of Delos Arnold.

*Living.*—Catalina Island; Santa Barbara Channel (Cooper).

*Pleistocene.*—Santa Barbara (Gabb; Arnold): San Pedro (Arnold).

### 259. Ocinebra foveolata *Hinds.*

*Murex foveolata* HDS., Proc. Zool. Soc., 1843, p. 127; Voyage Sulphur, p. 9, No. 13, Pl. III, figs. 15, 16, 1844. CPR., Brit. Assn. Rept., 1856, p. 205. TRYON, Man. Conch., Vol. II, p. 125, Pl. XXXVIII, fig. 465, 1880.

*Muricidea foveolata* HDS., COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 252.

*Ocinebra foveolata* HDS., WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 215.

Shell of medium size, fusiform; spire elevated; whorls six, angulated, with six or seven prominent, rounded, transverse ribs that rise to the prominence of nodes on the angle of the whorl; surface ornamented with numerous clear-cut, rather squarish, raised lines, and incremental lirulæ in the interspaces; suture deeply appressed, wavy; aperture subpyriform; outer lip thickened, denticulated; inner lip incrusted, smooth; canal long, narrow, slightly curved; columella not perceptibly widened; umbilicus subperforate.

*Dimensions.*—Long. 35 mm.; lat. 17 mm.; body-whorl 28 mm.; aperture, including canal, 20 mm.; canal 9 mm.; defl. 60 degrees.

Distinguishable by the broad, prominent, transverse ridges which rise to rounded nodes rather than to sharp points, as in some other members of the genus, and by the deep suture and rather long, narrow form of the shell. Specimen identified by Dr. Dall. Specimens of *O. perita* in the State Museum collection of fossils at Berkeley are labeled "*O. foveolata.*"

Rare in upper San Pedro series of San Pedro; one imperfect specimen found.

*Living.*—Baulinas Bay to Lower California (Cooper).

*Pleistocene.*—Santa Barbara; San Pedro (Cooper): San Pedro (Arnold).

### 260. Ocinebra interfossa *Carpenter.*

*Ocinebra interfossa* CPR., Brit. Assn. Rept., 1863, p. 663. GABB, Pal. Cal., Vol. II, p. 70, 1869. TRYON, Man. Conch., Vol. II, p. 131, Pl. XXXIX, fig. 484, 1880. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 254. KEEP, West Coast Shells, p. 24, fig. 5, 1892. WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 215.

Shell small, broadly fusiform; spire elevated, subacute; whorls five or six, angulated above; surface sculptured with numerous transverse and spiral ridges of nearly equal prominence, giving the surface a latticed appearance; suture deeply impressed, distinct; aperture subovate; outer lip thickened, slightly denticulated; inner lip smooth, incrusted; canal short, generally covered; columella twisted, squamose; umbilicus subperforate.

*Dimensions.*—Long. 13 mm.; lat. 7.2 mm.; body-whorl 10.mm.; aperture, including canal, 7.5 mm.; canal 2.5 mm.; defl. 55 degrees.

Distinguishable from other members of genus by strong, latticed sculpture, short canal and small size. Identified by Dr. Dall.

Rather common in upper San Pedro series at San Pedro; one in Pliocene at Deadman Island; found also in Lower San Pedro series at Deadman Island and San Pedro, and in the upper San Pedro series at Crawfish George's and Deadman Island. Found also in the Pleistocene at Pacific Beach, San Diego.

*Living.*—Sitka to San Diego (Cooper).

*Pleistocene.*—Santa Barbara (Cooper): San Pedro; San Diego (Arnold).

*Pliocene.*—San Pedro (Arnold).

### 261. Ocinebra keepi, sp. nov.

PLATE V, FIG. 9.

Shell of medium size, fusiform; spire elevated, subacute; whorls five to six, strongly angulated above, giving a tabulate appearance to upper portion; whorls crossed by about seven sharp frills, which flex forward, and rise to prominent points on the angle; anterior portion of whorl ornamented with five or six strong, rough, subangular spiral lines, more prominent on lower portion of whorl; posterior portion of whorl smooth between frills, except near suture, where the surface is roughened by laminated, incremental lines; suture deeply appressed, undulating, distinct; aperture subelliptical; outer lip thickened and slightly denticulated; inner lip enameled, slightly projecting; columella twisted, squamose, only slightly widened; umbilicus subperforate; canal of medium length, narrow, sometimes covered with overgrowing lips.

*Dimensions.*—Long. 35.5 mm.; alt. 21 mm.; body-whorl 26.5 mm.; aperture 20 mm.; canal 7.5 mm.; defl. 56 degrees.

Distinguishable from other members of the genus by the transverse frills. The type specimen shows the original reddish brown color. Pronounced a new species by Dr. Dall. Named in honor of Professor Josiah Keep of Mills College, who has done so much toward advancing the study of conchology on the Pacific Coast.

Rare in upper San Pedro series at San Pedro; type specimen found at Deadman Island in the upper San Pedro conglomerate. The specimen figured is the type, which is now in the United States National Museum. One specimen from the upper San Pedro series at the lumber yard, San Pedro.

*Pleistocene.*—San Pedro (Arnold).

### 262. Ocinebra lurida *Middendorf.*

*Tritonium luridum* MIDD., Mal. Ross., Pl. II., p. 150, Pl. IV., figs. 4, 5, 1849.
*Ocinebra lurida* MIDD., Cpr., Brit. Assn. Rept., 1863, p. 663. GABB, Pal. Cal., Vol. II., p. 70, 1869. TRYON, Man. Conch., Vol II, p. 131, Pl. XXXIX, figs. 481, 485, 1888. KEEP, West Coast Shells, p. 23, fig. 4, 1892. WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 215, Pl. XX, fig. 3.

Shell of medium size, fusiform; whorls six, convex, slightly angulated near posterior margin; upper whorls with several transverse ridges; surface ornamented with numerous rounded, raised lines; suture deeply impressed, distinct; body-whorl not extraordinaril yventricose; aperture subovate; outer lip thickened, denticulated; inner lip incrusted; columella widened; umbilicus subperforate; canal narrow, sometimes covered with overgrowing lips.

*Dimensions.*—Long. 25 mm.; lat. 13.3 mm.; defl. 55 degrees.

Distinguishable by lack of transverse ridges of any kind on body-whorl and its antecedent whorl. Specimen identified by Dr. Dall.

Rare in upper San Pedro series of San Pedro; one deformed specimen from Crawfish George's. Found in Pleistocene at Pacific Beach, San Diego.

*Living.*—Sitka to Santa Barbara (Cooper): San Pedro (U. S. Nat. Mus.).

*Pleistocene.*—San Pedro; San Diego (Arnold).

### 263. Ocinebra lurida *Midd.*, var. aspera *Baird.*

PLATE V, FIG. 12.

*Vitularia aspera* BAIRD, Proc. Zool. Soc., 1863, p. 66.
*Ocinebra lurida* var. *aspera* BAIRD, CPR., Brit. Assn. Rept., 1863, p. 663. TRYON, Man. Conch., Vol. II, p. 131, 1880. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 254.

Shell of medium size, fusiform; whorls six, convex, with about nine prominent, rounded transverse ribs; surface ornamented with numerous rounded, raised, spiral lines and fine incremental lirulæ in the interspaces; suture deeply impressed, distinct; body-whorl prominently ventricose, and with transverse, rounded ridges which become obsolete on columella; aperture subovate; outer lip thickened, denticulated; inner lip slightly flattened, incrusted; columella only slightly widened; umbilicus subperforate; canal straight, narrow.

*Dimensions.*—Long. 27 mm.; lat. 14 mm.; body-whorl 20 mm.; aperture, including canal, 16 mm., canal 6 mm.; defl. 55 degrees.

Distinguishable from *O. lurida* by more ventricose body-whorl, and by the rounded ridges on the lower whorls, which are lacking in *lurida*. Specimens identified by Dr. Dall.

Rather common in the upper San Pedro series at San Pedro, Los Cerritos, Crawfish George's and Deadman Island; also found in the lower San Pedro series at Deadman Island and San Pedro. Found in the Pleistocene at bath-house, Santa Barbara; and irrigating ditch, Ventura. The specimen figured is from the upper San Pedro series at San Pedro, and is now in the collection of Delos Arnold.

*Living.*—Sitka to Santa Barbara (Cooper).

*Pleistocene.*—Santa Barbara; San Pedro (Cooper): San Pedro (Arnold).

### 264. Ocinebra lurida *Midd.*, var. cancellina *Philippi.*

PLATE IX, FIG. 11.

*Fusus cancellinus* PHIL., Archiv. für Naturg, Bd. I, 1845, p. 67; Abbild., II, *Fusus*, Pl. III, fig. 2.
*Urosalpinx cancellinus* PHIL., TRYON, Man. Conch., Vol. II, p. 154, Pl. XXXIX, fig. 492, 1880.

Shell small, broadly fusiform; spire elevated, subacute; whorls four, convex; body-whorl ventricose; whorls crossed by about nine prominent, broad, rounded ribs, the interspaces ornamented with prominent rounded, raised spiral lines, between which are numerous squamose incremental lirulæ; suture not deeply impressed, rather indistinct, undulating; aperture subelliptical; outer lip slightly twisted, squamose, not widened; canal short, rather broad, uncovered; umbilicus subperforate.

*Dimensions.*—Long. 22 mm.; lat. 12.5 mm.; aperture 12.5 mm.; canal 4 mm.; defl. 62 degrees.

Distinguishable by broad and depressed form, broad, rounded ridges, and prominence of the spiral lines and incremental lirulæ. Specimen identified by Dr. Dall.

Rare in upper San Pedro series at San Pedro. The specimen figured is from the upper San Pedro series at San Pedro, and is now in the United States National Museum.

*Living.*—Straits of Magellan (Tryon).

*Pleistocene.*—San Pedro (Arnold).

### 265. Ocinebra lurida *Midd.*, var. cerritensis, var. nov.

PLATE V, FIG. 5.

Shell small, broadly fusiform, heavy; spire elevated, subacute; whorls four, convex, enlarging rapidly from the first whorl; body-whorl ventricose; whorls crossed by about nine prominent, rather narrow, rounded ribs, which extend to end of columella; interspaces ornamented with strong, raised, spiral lines; suture impressed, not very distinct; aperture subelliptical; outer lip thickened, with a row of about six prominent denticles; inner lip smooth, incrusted; columella not much widened, abruptly truncated at end; umbilicus subperforate; canal short, straight, narrow.

*Dimensions.*—Long. 17 mm.; lat. 10 mm.; body-whorl 14.5 mm.; aperture 11 mm.; canal 3 mm.; defl. 60 degrees.

Distinguishable from others of its genus by large body-whorl, depressed appearance, small size and heavy shell. Pronounced a new variety by Dr. Dall.

Rare in upper San Pedro series of the San Pedro region; first found at Los Cerritos; type from Crawfish George's; also found in the lower San Pedro series at Deadman Island and San Pedro. The specimen figured is the type, which is now in the United States National Museum.

*Pleistocene.*—San Pedro (Arnold).

### 266. Ocinebra lurida *Midd.*, var. munda *Carpenter.*

*Ocinebra lurida* var. *munda* CPR., Brit. Assn. Rept., 1863, p. 663. DALL, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 215, Pl. XX, fig. 3.

Shell small, fusiform, thick, solid; spire elevated, apex acute; whorls five or six, evenly convex; sculpture consists of rather low, rounded, transverse ridges (of which there are about twelve on the penultimate whorl) and equal, equidistant, rounded, raised, spiral lines (of which there are six on the penultimate whorl); suture quite deeply impressed; aperture elliptical; outer lip thickened with row of denticles interiorly; inner lip and columella smooth; canal short, narrow, generally covered.

*Dimensions.*—Long. 14 mm.; lat. 6.5 mm.; body-whorl 10 mm.; aperture, including canal, 7.5 mm.; canal 2.5 mm.

Distinguishable from others of the genus by its low, rounded, transverse ribs, which are of the same size and prominence from suture to suture, regular spiral lines

and slender shape. The sculpture of this species is less prominent than on the other species of this genus.

Several specimens from the lower San Pedro series of Deadman Island.

*Living.*—Catalina Island (Dall).

*Pleistocene.*—San Pedro (Arnold).

### 267. Ocinebra micheli *Ford.*

PLATE V, FIG. 15.

Shell small, elongate-fusiform; spire elevated, acute; whorls five or six, strongly angulated above, crossed by about nine prominent, rather sharp ridges, which are most prominent on angle; anterior portion of whorl with four or five strong, squamose, raised lines, between which are numerous squamose, incremental lirulæ; suture deeply appressed, distinct; aperture subovate; outer lip thickened, smooth interiorly; inner lip incrusted, slightly raised; columella long, twisted, squamose; canal long, narrow, nearly covered.

*Dimensions.*—Long. 16 mm.; lat. 7 mm.; body-whorl 11 mm.; aperture, including canal, 8.5 mm.; canal 4 mm.; defl. 40 degrees.

Resembles *O. perita* somewhat, but is distinguishable by more slender form, longer columella, and greater number of transverse ridges. Identified by Dr. Dall.

One specimen from the upper San Pedro series at Crawfish George's, which is figured, and is now in the collection of Delos Arnold.

*Living.*—West Coast North America.

*Pleistocene.*—San Pedro (Arnold).

### 268. Ocinebra perita *Hinds.*

*Murex peritus* HDS., Proc. Zool. Soc., 1843, p. 129; Voyage Sulphur, p. 9, Pl. III, figs. 23, 24, 1844.
*Ocinebra perita* HDS., TRYON, Man. Conch., Vol. II, p. 124, 1880.
*Muricidea perita* HDS., COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 252.

Shell of medium size, fusiform; whorls five, sharply angulated, with about six or seven rather sharp, transverse ridges which are most prominent on angle; surface ornamented with numerous raised lines, with squamose, incremental lirulæ in the interspaces; suture deeply appressed, wavy; aperture subovate; outer lip thickened, denticulated; inner lip smooth, incrusted; canal long, straight, narrow, sometimes covered; columella somewhat twisted, slightly widened; umbilicus subperforate.

*Dimensions.*—Long. 24 mm.; lat. 12.5 mm.; body-whorl 17 mm.; aperture, including canal 14 mm.; canal 6 mm.; defl. 60 degrees.

Distinguishable from *O. barbarensis* by less prominent points on angle of whorl, and by less prominent spiral lines. Identified by Dr. Dall as probably *O. perita.*

Several specimens labeled by Dr. Dall as "*O. interfossa*, leaning toward *O. perita*" had about one more transverse rib to the whorl than does the typical *O. perita*, the ribs were not so prominent on the angle, but the spiral lines were stronger than in the latter species. Comparing a series of both forms they are seen

to intergrade, and they do not vary enough to justify making a variety out of the new form.

Found in the lower San Pedro series at Deadman Island; and in the upper San Pedro series at Deadman Island, San Pedro, and Crawfish George's. Found in the Pleistocene at bath-house, Santa Barbara; and Pacific Beach, San Diego.

*Living.*—Santa Barbara to Lower California (Cooper).

*Pleistocene.*—Santa Barbara (Cooper; Arnold): San Pedro; San Diego (Arnold).

### 269. Ocinebra poulsoni *Nuttall.*

PLATE V, FIG. 2.

*Ocinebra poulsoni* NUTT., CPR., Brit. Assn. Rept., 1863, p. 663. NUTTALL, mss., CPR., Jour. de Conch., Vol. XII, 1865, p. 148. TRYON, Man. Conch., Vol. II, p. 130, Pl. XXXVIII, fig. 475, 1880. KEEP, West Coast Shells, p. 23, 1892. WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 215. COOPER, Bull. No. 4, Cal. St. Min. Bureau, Part 3, 1894, p. 30.

Shell of medium size, elongate-fusiform; spire elevated, compact; whorls six, deeply concave above, convex below, with rounded transverse ridges rising to prominent nodes on angle of lower part of whorl; nuclear whorls coarsely cancellated; ridges obsolete on concave portion of whorl; more or less prominent spiral ridges on lower portion of whorl; spiral sculpture faint on concave surface; fine incremental lines quite prominent; suture not deeply appressed, wavy; aperture semielliptical; outer lip denticulated; inner lip effuse, incrusted, smooth; canal short, narrow; columella slightly twisted, widened; umbilicus subperforate.

*Dimensions.*—Long. 32 mm.; lat. 16.5 mm.; body-whorl 23 mm.; aperture 16 mm.; canal 5 mm.; defl. 42 degrees.

The specimen described is a narrow form, some of the specimens showing a deflection of 55 degrees. Many of the specimens retain the coloration of the brown spiral bands. Specimens identified by Dr. Dall.

Rare in lower San Pedro series at Deadman Island and San Pedro; not uncommon in upper San Pedro series at San Pedro, Los Cerritos, Crawfish George's, and Deadman Island. Found also in the Pleistocene at Twenty-sixth Street, San Diego. The specimen figured is from the upper San Pedro series at San Pedro, and is now in the collection of Delos Arnold.

*Living.*—Santa Barbara to San Diego (Cooper): Lower California (Carpenter).

*Pleistocene.*—Ventura (Bowers): San Pedro; San Diego (Arnold).

## Subfamily *PURPURINÆ.*

### Genus **Purpura** *Bruguiére.*

Shell oblong-oval, last whorl large; spire generally short; aperture ovate, large, terminating in a very short oblique channel, or notched; columella flattened; outer lip simple.

*Purpura persica* Linné is a typical species.

### 270. Purpura crispata *Chemnitz.*

*Purpura crispata* CHEM., Conch. Cab., XI, Pl. 187, figs. 1802 and 1803, 1795; KUSTER, Conch. Cab., p. 105, Pl. XIX, figs. 3 and 4, 1837. CPR., Brit. Assn. Rept., 1863, p. 662. TRYON, Man. Conch., Vol, II, p. 175, Pl. LXIII, figs. 163–166, 168, 1880. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 261. KEEP, West Coast Shells, p. 33, fig. 13, 1892.

Shell fusiform, thick; spire elevated; apex subacute; whorls five to seven, convex or angulated, with one or more prominent spiral ridges on angular part of whorl; suture impressed, distinct; aperture ovate to elliptical; outer lip effuse, generally denticulate; inner lip incrusted, smooth; canal short, curved backwards; umbilicus subperforate.

*Dimensions.*—Long. 34 mm.; lat. 20 mm.; body-whorl 26 mm.; aperture, including canal, 22.5 mm.; canal 6 mm.; defl. 55 degrees.

The specimen whose dimensions are given was a small one, but the relative proportions in this specimen seemed to be about the average. A very variable species, some being nearly smooth and some almost spinous in their roughness. The smooth forms generally lack the denticulation of the outer lip. The shell texture is very well preserved in most of the Pleistocene specimens, some of them being almost indistinguishable from living shells.

Not common in the upper San Pedro series of San Pedro, Deadman Island, and Crawfish George's. Found in the Pliocene at Pacific Beach and Russ School, San Diego.

*Living.*—Sitka to Santa Barbara (Cooper).

*Pleistocene.*—Santa Barbara to San Diego (Cooper): San Pedro (Arnold).

*Pliocene.*—Seven Mile Beach, San Mateo County (Cooper): San Diego (Arnold).

### 271. Purpura saxicola *Valenciennes.*

*Purpura saxicola* VAL., Venus, Pl. VIII, fig. 4, 1846. CPR., Brit. Assn. Rept., 1863, p. 662, =*P. lapillus* COOPER (not LINN. sp., LAM.), GABB, Pal. Cal., Vol. II, p. 75, 1869. TRYON, Man. Conch., Vol. II, p. 174, Pl. LIII, figs. 152, 154*a*, 1880. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 262. KEEP, West Coast Shells, p. 31, fig. 11, 1892.

Shell small, semiglobular; spire slightly elevated; apex subacute; whorls four, angulated, tabular on top; body-whorl ventricose; surface ornamented with obsolete spiral ridges and fine incremental lines; suture impressed, distinct; aperture large, elliptical; outer lip smooth, thin, effuse; inner lip and columella flattened, incrusted, sharp; canal short.

*Dimensions.*—Long. 18 mm.; lat. 13 mm.; aperture, including canal, 16 mm.; canal 13.5 mm.; defl. 85 degrees.

Quite a variable form. All the Pleistocene specimens at hand show the mottled or banded reddish brown coloration. Distinguishable from *P. crispata* by the small spire, large body-whorl, large aperture, and smoothness of the shell.

Rare in upper San Pedro series of San Pedro; three specimens. Found in the Pleistocene at irrigating ditch, Ventura.

*Living.*—Alaska to San Diego; Lower California (Cooper).

*Pleistocene.*—Santa Barbara; San Pedro; Ventura (Arnold).

*Pliocene.*—Santa Rosa; Kirker's Pass; San Fernando (Cooper): Stanford University (Arnold).

### Subfamily *CORALLIOPHILINÆ.*

### Genus **Coralliophila** *H. & A. Adams.*

Shell broadly fusiform; nuclear whorls smooth; postnuclear whorls with rasp-like surface, and somewhat open umbilicus.

*Coralliophila neritoidea* is a characteristic species.

#### 272. **Coralliophila nux** *Reeve.*

*Murex nux* RVE., Conch. Icon., sp. 81.
*Coralliophila nux* RVE., TRYON, Man. Conch., Vol. II, p. 210, Pl. LXVI, figs. 368, 374, 1880.

Shell purpuroid shaped; whorls angular; surface rough and cancellated by spiral and transverse squamose ridges, the spiral ridges being the most prominent; suture deep. Longitude about 12 millimeters.

This specimen is too imperfect to allow of a good description. Dr. Dall labeled this specimen "*Coralliophila*, probably var. of *nux*."

One specimen from the upper San Pedro series of San Pedro.

*Living.*—Mazatlan to Panama; Gallapagos Islands (Tryon).

*Pleistocene.*—San Pedro (Arnold).

## Suborder STREPTODONTA.

## Superfamily PTENOGLOSSA.

### Family LXII. SCALIDÆ.

### Genus **Scala** *Humphrey.*

Shell mostly pure white and lustrous; turreted, many whorled; whorls round, sometimes separated, ornamented with numerous transverse ribs; aperture round; peristome continuous.

*Scala pretiosa* Linn. is a characteristic species.

### 273. Scala bellastriata *Carpenter*.

PLATE IX, FIG. 17.

*Scalaria bellastriata* CPR., Brit. Assn. Rept., 1863, p. 660; Proc. Cal. Acad. Sci., Vol. III, 1864, p. 22. GABB, Pal. Cal., Vol. II, p. 78, 1869. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 263.

*Scala bellastriata* CPR., WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 209.

Shell conical, with elevated spire; whorls six, rounded, each having fifteen thin varices; suture almost separating whorls; varices spinous at shoulder, a few of the varices thickened; intervarical spaces ornamented with spiral ridges; aperture slightly elliptical, with longer axis vertical.

*Dimensions.*—Alt. 17.5 mm.; lat. 10 mm.; defl. 42 degrees.

This species is easily distinguishable by its low spire and by its spiral ornamentation. The only other member of this genus found in this locality which has spiral sculpture is *S. hemphilli*, which has a much slenderer spire and a less impressed suture. The figure of this species is of a living shell from San Pedro, which is now in the collection of Delos Arnold.

Rare; only four found in the upper San Pedro series of San Pedro.

*Living.*—San Pedro to San Diego (Cooper).

*Pleistocene.*—Santa Barbara (Cooper): San Pedro (Arnold).

### 274. Scala crebricostata *Carpenter*.

*Scalaria crebricostata* CPR., Brit. Assn. Rept., 1863, p. 660; Proc. Cal. Acad. Sci., Vol. III, 1864, p. 222. GABB, Pal. Cal., Vol. II, p. 78, 1869. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 263.

Shell turreted, thin; spire consists of eight convex whorls, each with fourteen to eighteen slightly oblique, sharp, thin, reflexed, transverse varices; varices show a slightly coronate appearance at the shoulder; suture deep and distinct. Deflection 22 degrees.

Some of the specimens have only slightly reflexed varices, and the amount of coronation varies in different individuals.

Distinguishable from *S. indianorum* by thinner shell, thinner and sharper varices, and more impressed suture; distinguishable from *S. tincta* by more numerous, and generally more reflexed varices; distinguishable from *S. hindsii* by more numerous and less coronated varices. Specimens identified as questionable by Dr. Dall.

Rare in the upper San Pedro series at San Pedro and Deadman Island; also in lower San Pedro series at San Pedro. Found in the Pleistocene at Barlow's ranch and irrigating ditch, Ventura; and at Twenty-sixth Street, San Diego.

*Living.*—Monterey to San Diego (Cooper).

*Pleistocene.*—Santa Barbara; San Pedro (Cooper): San Pedro; Ventura; San Diego (Arnold).

### 275. Scala hemphilli *Dall.*

*Scala hemphilli* DALL, Proc. U. S. Nat. Mus., Vol. I, 1878, p. 16. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 263.

Shell resembling robust *S. tincta;* nine to twelve varices, coronated behind near suture: surface of whorls beneath the varices longitudinally delicately sculptured with alternate grooves and riblets. Deflection 30 degrees.

Distinguishable from *S. bellastriata* by less prominent spiral sculpture and by a less deflection; from other members of the genus found here by its deflection and the spiral sculpture. The specimen described was identified by Dr. Dall.

One immature specimen from the upper San Pedro series of San Pedro.

*Pleistocene.*—San Diego (Dall): San Pedro (Arnold).

*Pliocene.*—San Diego well (Dall).

### 276. Scala hindsii *Carpenter.*

*Scalaria hindsii* CPR., Proc. Zool. Soc., 1856, p. 165; Brit. Assn. Rept., 1856, p. 336; 1863, p. 660. KEEP, West Coast Shells, p. 49, fig. 31, 1892, = *S. subcoronata* CPR., (*fide* COOPER, Bull. No. 4, Cal. St. Min. Bureau, Part 3, 1894, p. 31).

*Scala hindsii* CPR., WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 209.

Shell small, turreted, thin; whorls eight, evenly convex; varices eight to twelve, sharp, thin, sometimes reflexed, very prominently coronated just anterior to suture; suture deep, distinct; aperture subcircular; lip slightly thickened; inner lip slightly incrusted.

*Dimensions.*—Long. 11.5 mm.; lat. 5.2 mm.; defl. 27 degrees.

Distinguishable from *S. indianorum* by smaller and thinner shell, fewer, thinner, and more coronated varices, and deeper suture; distinguishable from *S. tincta* by smaller shell, and fewer and more coronate varices; distinguishable from *S. crebricostata* by fewer and more coronate varices. Several specimens were identified by Dr. Dall.

Rare in upper San Pedro series at San Pedro, Deadman Island, Crawfish George's, and Los Cerritos; also reported from lower San Pedro series at Deadman Island and San Pedro.

*Living.*—Santa Barbara (Jewett): San Pedro (Williamson): Panama (Carpenter).

*Pleistocene.*—San Pedro (Arnold).

### 277. Scala indianorum *Carpenter.*

PLATE V, FIG 4.

*Scala indianorum* CPR., Brit. Assn. Rept., 1863, p. 660; Ann. & Mag. Nat. Hist., 3rd Ser., Vol. XV, 1865, p. 31. TRYON, Man. Conch., Vol. IX, p. 70, Pl. XIV, fig. 48, 1887. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 263. KEEP, West Coast Shells, p. 50, 1892.

*Scala indianorum* CPR., WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 210.

Shell thick, elongated; spire elevated; apex acute; whorls ten, rounded, with twelve to sixteen heavy, reflexed varices; varices striated with fine incremental lines; suture deep; aperture subcircular; inner lip thickened, forming columella.

*Dimensions.*—Long. 26.5 mm.; lat. 9 mm.; defl. 32 degrees.

Distinguishable from *S. tincta* by heavier shell, thicker and generally more numerous varices, which are reflexed, and by a more solid appearance caused by the less sunken suture; distinguishable from *S. hindsii* by more whorls, thicker shell, more varices, which are thicker, more reflexed and less coronate, and by less prominent sutures; distinguishable from *S. crebricostata* by thicker shell, thicker varices, which are more reflexed, and by a less prominent suture. Several specimens of this species were identified by Dr. Dall.

Two from the Pliocene of Deadman Island; common in the lower and upper San Pedro series of San Pedro and vicinity. The specimen figured is from the upper San Pedro series at San Pedro, and is now in the collection of Delos Arnold.

*Living.*—Straits of Fuca to San Diego (Cooper).

*Pleistocene.*—Santa Barbara (Cooper): San Diego (Dall): San Pedro (Arnold).

*Pliocene.*—San Pedro (Arnold).

### 278. Scala tincta *Carpenter.*

PLATE V, FIG. 3.

*Scalaria tincta* CPR., Brit. Assn. Rept., 1863, p. 660. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 263.

*Scalaria indianorum* var. *tincta* CPR., Ann. & Mag. Nat. Hist., 3rd Ser., Vol. XV, 1865, p. 31. TRYON, Man. Conch., Vol. IX, p. 70, Pl. XIV, fig. 49, 1887.

Shell thin, elongate; spire elevated; apex acute; whorls nine to ten, rounded, with ten to twelve thin varices, which are generally not reflexed; suture deep; aperture subcircular; inner lip only slightly thickened.

*Dimensions.*—Long. 25 mm.; lat. 10 mm.; defl. 28 degrees.

Distinguishable from *S. indianorum* by more delicate shell, thinner varices, which are not reflexed as a rule, thinner lip and much deeper suture; distinguishable from *S. hindsii* by more numerous varices, which lack the distinct coronation, and by more whorls and less deflection; distinguishable from *S. crebricostata* by fewer and less reflexed varices. Specimens identified by Dr. Dall.

Rather common in upper, and rare in lower San Pedro series of San Pedro and vicinity. Found in the Pleistocene at Barlow's ranch, Ventura; at Pacific Beach and Twenty-sixth Street, San Diego; and in the Pliocene at Pacific Beach and Russ School, San Diego. The specimen figured is from the upper San Pedro series at San Pedro, and is now in the collection of Delos Arnold.

*Living.*—Santa Cruz to San Diego (Cooper).

*Pleistocene.*—San Diego (Cooper): San Pedro (Cooper; Arnold): Ventura; San Diego (Arnold).

*Pliocene.*—San Diego (Cooper; Arnold).

### Genus **Opalia** *H. & A. Adams.*

Shell turriculated, imperforate; whorls united, the last with a rib at the base.

*Opalia coronata* Lam. is a characteristic species.

### [S. D.] **Opalia anomala** *Stearns.*

*Opalia anomala* STEARNS, Proc. Phil. Acad. Nat. Sci., 1875, p. 464, Pl. XXVII, fig. 1. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 255. DALL, Trans. Wagner Inst. Sci., Vol. III, Part 2, 1892, p. 245.

Shell solid, imperforate, elongated, conical; spire gradually tapering; whorls convex, when perfect probably eleven to fourteen in number, nearly smooth, being marked only by incremental, and, in some specimens, by an outgrowth varix; suture well defined; basal whorl traversed spirally by an inconspicuous rib, varying in prominence, in some specimens barely discernible; the convexity or angularity of the lower part of the basal whorl modified by the presence or absence of the basal rib.

*Dimensions.*—Long. 53 mm.; lat. 19 mm.; body-whorl 24.5 mm.; aperture 11 mm.

This large, nearly smooth species has so far been reported only from the Pliocene of San Diego, where it is quite common.

*Pliocene.*—San Diego (Hemphill; Stearns; Arnold).

### 279. **Opalia borealis** *Gould.*

*Scalaria borealis* GLD., Wilkes' Exped., Vol. XII, 1852, p. 207. TRYON, Man. Conch., Vol. IX, p. 76, Pl. XVI, fig. 89, 1887.

*Opalia borealis* GLD., CPR., Brit. Assn. Rept., 1863, p. 660. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 255. KEEP, West Coast Shells, p. 49, fig. 30, 1892.

*Scala (Opalia) borealis* CPR., WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 210.

Shell small, turreted, thick; apex generally decollated; whorls seven, only slightly convex; varices eight, rounded, thick, prominent, and forming radiating ridges from the apex; suture impressed, distinct; body-whorl squarely angulated at base, with keel on angle; base flat, smooth; aperture subovate; outer lip thin, effuse; inner lip only slightly incrusted.

*Dimensions.*—Long. 15 mm.; lat, 6 mm.; defl. 22 degrees.

The specimens described were identified by Dr. Dall.

Rare in upper San Pedro series of San Pedro; two specimens.

*Living.*—Kamtschatka; Straits of Fuca to San Diego (Cooper).

*Pleistocene.*—Santa Barbara (Cooper): San Pedro (Arnold).

### 280. Opalia crenatoides *Carpenter*, var. insculpta *Carpenter*.

*Opalia (? crenatoides)* var. *insculpta* CPR., Brit. Assn. Rept., 1863, p. 660; Ann. & Mag. Nat. Hist., 3rd Series, Vol. XVII, 1866, p. 277. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 255.

Shell of medium size, elongated, thick, milk-white; spire elevated, with blunt apex; whorls six, convex; first and second post-nuclear whorls more convex than the remaining whorls, angulated, nearly smooth; last four post-nuclear sharply and strongly angulated above, flattened along middle, and quite abruptly contracted at base; whorls ornamented with twelve to fourteen radiating transverse ribs, which are obsolete on the sides of the whorl, faintly developed at the base, and strongly developed on the top of the whorl, where they are appressed against the antecedent whorl, and appear like nodes on the angle of the whorl; a faint sutural riblet is sometimes noticeable on the base of the whorl; above this sutural riblet are faint holes, corresponding to the intercostal spaces; fine incremental striations are visible over the whole surface of the shell; the base of the body-whorl, just below the angle, is ornamented with a prominent, wide, elevated rib; aperture elliptical; outer lip thickened, rounded, slightly expanded at columella; this lip is finely, concentrically striated; inner lip rounded, smooth.

*Dimensions.*—Long. 16.4 mm.; lat. 8.3 mm.; body-whorl 9.9 mm.

This species is distinguishable by its broad form and sharply angular whorls, which are prominently sculptured above, with obsolete sculpture on the sides of the whorl. Carpenter's type specimen was a post-Pliocene fossil from Santa Barbara.

Rare in the upper San Pedro series at Deadman Island.

*Living.*—Santa Cruz to Santa Barbara (Cooper).

*Pleistocene.*—Santa Barbara (Cooper): San Pedro (Arnold).

### [S. D.] Opalia varicostata *Stearns*.

*Opalia varicostata* STEARNS, Proc. Phil. Acad. Nat. Sci., 1875, p. 463, Pl. XXVII, figs. 2–5. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 255. DALL, Trans. Wagner Inst. Sci., Vol. III, Part 2, 1892, p. 245.

Shell elongated-conical, turreted, tapering, solid, imperforate; aperture ovate; peristome continuous, thickened; dingy to clear white; suture well defined; whorls united, exceedingly variable in convexity and altitude; specimens all decollate or truncated, equally solid, though varying in length from 20 to 60 millimeters, showing four and one-half whorls within the first measurement to five in the latter; longitudinal ribs nine to twelve, varying in number, prominence and regularity, as well as in obliquity and thickness; suture more or less waved, dependent upon the prominence of the ribs, which terminate anteriorly at and join a transverse (spiral) rib at about the middle of the basal whorl.

*Dimensions of a Rather Small Specimen.*—Long. 34 mm.; lat. 14.5 mm.; body-whorl 17 mm.; aperture 9 mm.

This magnificent but variable species has so far been reported only from the Pliocene of San Diego, where it is quite common.

*Pliocene.*—San Diego (Hemphill; Stearns; Arnold).

## Superfamily GYMNOGLOSSA.

## Family LXIII. EULIMIDÆ.

### Genus **Eulima** *Risso.*

Shell small, white, and polished; slender, elongated with numerous level whorls; spire often curved to one side; obscurely marked on one side by a series of periodic mouths which form prominent ribs internally; apex acute; aperture oval, pointed above; outer lip thickened internally; inner lip reflected over the pillar, not umbilicated.

*Eulima tortuosa* Adams is a characteristic species.

### 281. **Eulima falcata** *Carpenter.*

PLATE IX, FIG. 15.

*Eulima falcata* CPR., Proc. Zool. Soc., 1865, p. 280.

Shell small, elongated, thin, white, glossy; spire very acute, curved into scythe-shape; whorls ten, flat; suture indistinct, not impressed; body-whorl subangular at base; base elongated; aperture pyriform, seemingly appressed to side of shell out of its normal position; outer lip acute and rounding; inner lip concave.

*Dimensions.*—Long. 6.5 mm.; lat. 3 mm.; body-whorl 3 mm.; aperture 2.5 mm.; defl. 30 degrees.

Distinguishable from *E. micans* by subangulated body-whorl, eccentric aperture and curved spire; distinguishable from *E. hastata* by curved spire and more eccentric aperture. The specimens described were identified by Dr. Dall.

One specimen each from the lower San Pedro series at Deadman Island and the upper San Pedro series at San Pedro. The specimen figured is from the lower San Pedro series at Deadman Island, and is now in the collection of Delos Arnold.

*Living.*—Acapulco (Carpenter).

*Pleistocene.*—San Pedro (Oldroyd; Arnold).

### 282. **Eulima hastata** *Sowerby.*

PLATE IX, FIG. 9.

*Eulima hastata* SBY., Proc. Zool. Soc., 1834, p. 7. CPR., Brit. Assn. Rept , 1856, p. 335. TRYON, Man. Conch., Vol. VIII, p. 273, Pl. LXIX, fig. 39, 1886.

Shell small, slender, turreted; apex acute; whorls nine, flat, smooth; suture indistinct, not impressed; body-whorl angular below, short; aperture suboval, abruptly truncated in front.

*Dimensions.*—Long. 7.4 mm.; lat. 2.5 mm.; body-whorl 3.1 mm.; aperture 2 mm.; defl. 22 degrees.

Distinguishable by the short, angular base, and short, truncated aperture. In other respects like *E. micans*. Specimens identified by Dr. Dall.

Four found in upper San Pedro series at San Pedro; and one in the lower San Pedro series at Deadman Island. Found in the Pleistocene at Barlow's ranch,

Ventura; and at Spanish Bight, San Diego. The specimen figured is from the upper San Pedro series at San Pedro, and is now in the collection of Delos Arnold.

*Living.*—Gulf of California; Ecuador (Carpenter).

*Pleistocene.*—San Pedro; Ventura; San Diego (Arnold).

### 283. Eulima micans *Carpenter*.

PLATE IX, FIG. 12.

*Eulima micans* CPR., Brit. Assn. Rept., 1863, p. 659. REEVE, Conch. Icon., p. 33, 1865. TRYON, Man. Conch., Vol. VIII, p. 272, Pl. LXIV, figs. 29, 30, 1886. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 240. KEEP, West Coast Shells, p. 50, fig. 32, 1892. WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 209.

Shell small, turreted, glossy; apex acute; whorls ten, flat; body-whorl convex; suture distinct, not impressed; aperture elongate-ovate; outer lip thin, rather arcuate; inner lip slightly incrusted.

*Dimensions.*—Long. 12 mm.; lat 3.2 mm.; defl. 25 degrees.

Distinguishable from *E. falcata* by straight spire and less bulging outer lip; distinguishable from *E. hastata* by even convexity of body-whorl. The specimens described were identified by Dr. Dall.

Found in the lower San Pedro series at Deadman Island and San Pedro, and in the upper San Pedro series at Crawfish George's, Los Cerritos, and San Pedro. The specimen figured is from the lower San Pedro series at Deadman Island, and is now in the collection of Delos Arnold. Found also in the Pleistocene at Barlow's ranch, Ventura, and at Spanish Bight, San Diego.

*Living.*—Straits of Fuca to San Diego (Cooper).

*Pleistocene.*—Santa Barbara to San Diego (Cooper): San Pedro; Ventura; San Diego (Arnold).

## Family LXIV. PYRAMIDELLIDÆ.[1]

### Genus **Turbonilla** *Risso*.

*Turbonilla* RISSO, Hist. Nat. Eur. Merid., Vol. IV, p. 224, 1826. Type, *Turbonilla typica* DALL & BARTSCH, =*Turbonilla plicatula* RISSO, 1826, *non Turbo* (=*Turbonilla*) *plicatulus* BROCCHI, 1814.

Shell with sinistral nucleus, slender, having many whorls, with axial[2] or spiral sculpture, or both; columella straight or twisted, usually with a single fold, which is rarely obsolete; operculum horny, subspiral, with spiral striæ on its outer surface.

Animal with wide, flattened tentacles; mentum elongated, flattened, and bilobed in front; foot large, short, auriculated anteriorly.

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[1] The portion of the text relating to this family has been prepared, under the supervision and with the assistance of W. H. Dall, by Paul Bartsch, aid in the United States National Museum.

[2] Sculpture following the direction of the coil of the whorls is in these diagnoses referred to as *spiral*. That at right angles to the spiral sculpture, or in general parallelism with the axis of the shell, is called *axial*. An endeavor has been made to include all the Pleistocene species known from California, some of which, though found at San Diego, have not yet been obtained at San Pedro.

The species of this genus are distributed in all seas. All our West American forms have the columellar fold internal and hardly to be seen without breaking away part of the whorls.

The number of species is so great, and they are so similar to one another, that a number of sections, based chiefly on the types of sculpture, have been found convenient in treating of them. Most of these sections grade into one another through peripheral species.

Section *Strioturbonilla Sacco.*

*Strioturbonilla* SACCO, I. Moll. del Piedmonte e della Liguria, p. 94, 1892.

Shell as in *Chemnitzia*, but very finely and closely spirally striated on the spire and base.

Type, *Strioturbonilla alpina* Sacco, *l. c.*

### 284. Turbonilla (Strioturbonilla) muricata *Carpenter.*

*Chemnitzia muricata* CPR., Mazatlan Cat., Brit. Assn. Rept., 1856, p. 260.

Shell small, slender, solid, rather thin, milk-white; nuclear whorls two and one-half, helicoid, smooth, one-third sunken, their axis being at right angles to the axis of the post-nuclear whorls; post-nuclear whorls flattened, ornamented by eighteen to twenty-two very prominent, elevated, convex-topped, slightly oblique axial ribs, which extend to the suture posteriorly, but fuse just before reaching the suture anteriorly; ribs on body-whorl fuse abruptly at angle; the intercostal spaces appear as deep channels about as wide as the ribs; the suture appears very distinct, owing to a sharp angulation on the upper part of the whorl, and a slight contraction at the base; body-whorl rather short, rounded, smooth on base, except for fine, incremental lines; aperture subquadrate, the outer lip meeting the columella at almost right angles.

*Dimensions.*—Long. 5.4 mm.; lat. 1.3 mm.; altltude of body-whorl, 1.7 mm.

This species resembles *T. stearnsii*, but may be distinguished from that species by more elevated, narrower and more numerous ribs and by the stronger angulation above. The specimen examined lacked prominent spiral sculpture as far as the writer was able to determine. This specimen was identified by Dr. Dall, but the species was omitted from the text prepared by Dall and Bartsch.

Rather common in the upper San Pedro series of San Pedro and Los Cerritos; rare in the lower San Pedro series at Deadman Island and San Pedro.

*Living.*—Gulf of California to Mazatlan (Carpenter).

*Pleistocene.*—San Pedro (Arnold).

### 285. Turbonilla (Strioturbonilla) similis *C. B. Adams.*

*Chemnitzia similis* C. B. ADS., Catalogue Panama Shells, No. 228, Ann. N. Y. Lyc. Nat. Hist., Vol. V, 1852, p. 392.

Shell small, slender, solid, milk-white, thick; nuclear whorls two and one-half, smooth, helicoid, about one-third sunken, their axis being at right angles to the axis of the post-nuclear whorls; post-nuclear whorls nine, somewhat flattened, ornamented by fourteen to eighteen prominent, broad, convex, oblique, axial ribs, which traverse nearly the whole of the exposed

portion of the whorls, but fuse anteriorly before reaching suture; the ribs are bent slightly forward near their posterior extremity; intercostal spaces deep, narrow; spiral sculpture fine but conspicuous; the sutures are deeply impressed, with smooth sides, caused by the fusion of the ribs before reaching the sutures; body-whorl rounded, smooth below, except for minute incremental lines and spiral ornamentation. Aperture subquadrate; the outer lip joins the straight, somewhat revolute columella at a right angle.

*Dimensions.*—Long. 5 mm.; lat. 1.1 mm.; altitude of body-whorl 1.4 mm.

This species somewhat resembles *T. stearnsii*, but is distinguishable from that species by the less number and greater prominence of the ribs, which in some cases bend slightly forward near their posterior extremity. *T. similis* was identified by Dr. Dall; but the species was omitted from the text prepared by Dall and Bartsch.

Rare in the lower San Pedro series at Deadman Island and San Pedro; common in the upper San Pedro series at San Pedro and Los Cerritos.

*Living.*—Gulf of California to Panama (Carpenter).

*Pleistocene.*—San Pedro (Arnold).

### 286. Turbonilla (Strioturbonilla) stearnsii *D. & B.*, sp. nov.

PLATE II, FIGS. 5 AND 5*a*.

Shell milk-white, rather stout; nuclear whorls two, small, helicoid, their axis being at right angles to the axis of the post-nuclear whorls; post-nuclear whorls very slightly convex, almost flattened, somewhat contracted at the base, and strongly shouldered at the summit, traversed by eighteen to twenty-six oblique, flexuose, axial ribs, which render the summits of the whorls wavy; intercostal spaces deep, terminating a little above the periphery, thus leaving a narrow, plain band above the suture, as in *T. torquata stylina*; the entire surface of the whorls is marked by numerous faint, wavy, spiral striations, which also ornament the otherwise plain basal portion of the last whorl; suture well defined, slightly channeled; aperture subovate, anterior angle obtuse; outer lip thin, joining the short, somewhat revolute columella in a gentle curve.

*Dimensions.*—Long. 9.2 mm.; diam. 2.3 mm.

The type, which has eleven and one-half post-nuclear whorls, is from the post-Pliocene of San Diego.

This species in a general way resembles *T. torquata stylina*, but differs from it in being much more robust, of greater diameter throughout, and in having the fine, wavy sculpture characteristic of the section.

*Turbonilla (Strioturbonilla) stearnsii* occurs quite abundantly in the post-Pliocene deposits at San Diego and San Pedro. It also occurs recent in the Gulf of California. The name is proposed in honor of Dr. R. E. C. Stearns of Los Angeles, who collected many specimens of this group.

### 287. Turbonilla (Strioturbonilla) torquata *Gould.*

PLATE II, FIGS. 4 AND 4*a*.

*Chemnitzia torquata* GLD., Bost. Jour. Nat. Hist., Vol. IV, 1853, p. 384, Pl. XIV, fig. 16.

Shell slender, solid, milk-white, entire surface marked by faint, wavy, spiral striations; nuclear whorls three, helicoid, their axis being at right angles to and to one side of the post-nuclear

whorls; post-nuclear whorls somewhat flattened, ornamented by sixteen to twenty-two broad, oblique, somewhat flexuose axial ribs, which traverse five-sixths of the exposed portion of the whorls, then fuse, leaving a band above the suture and the base of the last whorl devoid of sculpture; the intercostal spaces appear as grooves gouged out of the shell, their bases marking the fusing point of the ribs; they are equal to the ribs in breadth; the sutures are well defined, owing to the very slight shouldering of the summit and the slight contraction of the base of the whorls; last whorl slightly angular at the periphery; aperture subovate; the rather thick outer lip joins the straight, somewhat revolute columella at almost a right angle.

*Dimensions.*—Long. 10.6 mm.; diam. 2.5 mm.

The specimen figured is from the post-Pliocene of San Diego.

This species occurs living along the California coast at present, but appears far more abundant in the fossil state. More than five hundred individuals referable to this form have been examined, only six of which were recent, the remainder being post-Pliocene fossils from the vicinity of San Pedro and San Diego.

### 288. Turbonilla (Strioturbonilla) torquata, var. stylina *Carpenter.*

PLATE I, FIGS. 10 AND 10*a*.

*Chemnitzia (? torquata* var.*) stylina* CPR., Ann. Mag. Nat. Hist., 3rd Ser., Vol. XV, 1865, p. 396.

Shell like *T. torquata*, but more slender, with but two nuclear whorls; having more axial ribs, twenty-two to twenty-eight on the post-nuclear whorls, and the intercostal spaces extending further down upon the whorls, thus diminishing the breadth of the plain band above the sutures; entire surface marked by faint, wavy, spiral striations.

*Dimensions.*—Long. 8 mm.; diam. 1.9 mm.

The specimen figured is from Monterey. This variety has been found as far north as Port Etclees, Alaska. It occurs abundantly as a post-Pliocene fossil in the vicinity of San Pedro and San Diego.

### Section *Lancea Pease.*

*Lancea* PEASE, Am. Journ. Conch., Vol. III, 1867, p. 293. Type, *Turbonilla* (*Lancea*) *elongata* PEASE, =*Pyrgostylus* MONTEROSATO, Conch. Medit., p. 90, 1884.

*Turbonillas* with strong axial ribs and spiral sculpture, provided with thickened varices at irregular intervals on the spire, which are usually accompanied by internal lirations of the outer lip.

### 289. Turbonilla (Lancea) aurantia *Carpenter.*

*Chemnitzia tridentata* (? var.) *aurantia* CPR., Brit. Assn. Rept., 1863, p. 659; Jour. de Conch., Vol. XII, 1865, p. 147.

Shell small, slender, solid, rather thick, reddish-brown; first three post-nuclear whorls convex, five remaining post nuclear whorls (nearly) flat; whorls ornamented by twenty to twenty-six broad, evenly rounded, only very slightly oblique axial ribs, which extend nearly from suture to suture; the intercostal spaces appear as narrow grooves, their width is much less than the width of the ribs; the spiral striations on the base and between the ribs are very faint; the sutures are well defined and deep, owing to a distinct shouldering of the whorls above, and an equal contraction of the whorl at

the base; last whorl slightly angular at the periphery, base of this whorl smooth except for very fine axial, incremental lines, and nearly obsolete spiral striations; aperture subquadrate, the thick outer lip joins the nearly straight, somewhat revolute columella at almost a right angle.

*Dimensions.*—Long. 6 mm.; lat. 1.8 mm.; body-whorl, altitude 2 mm.

This species somewhat resembles *T. tridentata* in general appearance, but may be distinguished from that species by the greater number of ribs, which are closer together and broader, the narrower interspaces and fewer whorls. The specimen described lacks the nuclear whorls, which were broken off; the spiral sculpture on this specimen is also very faint, and would have been overlooked if a very high-power magnifier had not been used. This specimen was identified by Dr. Dall; but the species was omitted from the text prepared by Dall and Bartsch.

Rare in the lower San Pedro series at Deadman Island and San Pedro; and in the upper San Pedro series at Los Cerritos and San Pedro.

*Living.*—Puget Sound to Santa Barbara (Carpenter): San Pedro (Williamson).

*Pleistocene.*—San Pedro (Arnold).

### 290. Turbonilla (Lancea) tridentata *Carpenter.*

PLATE II, FIGS. 1 AND 1*a*.

*Chemnitzia tridentata* CPR., Jour. de Conch., Vol. XIII (3rd Ser., Vol. V), 1865, p. 147.

Shell large, broad; chestnut colored, obscurely banded; nuclear whorls three, helicoid, about one-third immersed, scarcely extending beyond the margin of the spire, their axis being at a right angle to the axis of the later whorls; post-nuclear whorls slightly convex, somewhat contracted below and slightly shouldered at the summit; traversed by about twenty to twenty-four strong, well-rounded, somewhat oblique axial ribs, which continue faintly over the decidedly angular periphery of the last whorl and the base to the umbilical region; these ribs are considerably enfeebled on the last whorl of old shells and frequently become almost obsolete on these; the exposed portion of the whorls is traversed by six to ten spiral grooves, which appear most prominently in the shallow and broad intercostal spaces, and less so on the ribs; these deep spiral lines are regularly spaced, leaving a broader interval on the middle of the exposed portion of the whorl; the base of the last whorl is likewise ornamented by spiral grooves, but here they appear less developed than on the spire; in addition to this the entire surface of the shell is marked by numerous very fine, somewhat wavy, spiral and axial striæ, which show most prominently on the last whorl and base, and give the shell a very minutely reticulated secondary sculpture; at irregular intervals the whorls are marked by thick callous varices, which are usually of a lighter color than the remainder of the shell; aperture large, subquadrate; posterior angle acute; outer lip thin, having three strong internal lirations, joining the whitish, short, straight, revolute columella at a little less than a right angle; by transmitted light two spiral, light color-bands become apparent on the inside of the lip, each of which is bordered by a zone of a darker color than the remaining shell; the general color effect of the exterior is that of a flesh-colored shell, covered by a dark epidermis, which is stretched tight over the ribs, permitting the lighter color beneath to shine through it at their summits.

*Dimensions.*—Long. 11.1 mm.; diam. 3.2 mm. (Dr. Carpenter's type, collected at Monterey, and having 11 post-nuclear whorls). Long. 12.8 mm.; diam. 3.6 mm. (Specimen figured, which is from San Pedro).

Fossil specimens from the post-Pliocene of California are larger, have fewer ribs, and more of the deep revolving lines than recent ones.

### 291. Turbonilla (Lancea) pentalopha *D. & B.*, sp. nov.

PLATE I, FIGS. 1 AND 1 *a*.

Shell chocolate-brown, inflated, stubby; nuclear whorls three, helicoid, moderately large, about one-third immersed, their axis being at a right angle to the axis of the later whorls; post-nuclear whorls at first a little rounded, later flattened, scarcely contracted at base, shouldered at the summit, adorned by twenty to twenty-eight strong, rounded, slightly oblique and somewhat flexuose axial ribs, which pass over the periphery of the last whorl and gradually disappear on the base; intercostal spaces rather deep, marked by five or six narrow, deep, subequally spaced spiral grooves, which encroach upon the ribs and in places extend over them; base of the last whorl very short, abruptly rounded, depressed at the umbilical region, marked by seven equally-spaced spiral striæ of the same nature as those of the exposed portion of the preceding whorls, the first one above and the first one below the periphery are a little farther apart than the rest and map out the path for the shoulder of the succeeding whorl; aperture large, ovate; outer lip thin, meeting the short, somewhat twisted and revolute columella in a broad curve; the reflexing of the thin columella and the sudden curving of the base cause the shell to appear subumbilicate.

By transmitted light the ribs become apparent on the inside of the outer lip, and the spiral striæ appear as so many faint red bands; at irregular intervals five strong spiral liræ are developed on the inside of the outer lip, the upper four being equally spaced, the fifth or anterior one being a little closer to its neighbor; no varices appear to accompany the internal lirations, a character in which it differs from typical *Lancea*.

*Dimensions.*—Long. 8.5 mm.; diam. 2.3 mm.

The type, which is figured, was collected at San Diego, and has ten post-nuclear whorls.

Recent specimens appear to range from San Pedro to Lower California. Fossils of this species have been found at Deadman Island.

#### Section *Pyrgiscus Philippi*.

*Pyrgiscus* PHIL., Weig. Arch., Bd. VII, 1841, p. 50. Type, *Melania rufa* PHIL., l. c. =*Pyrgostelis* MONTEROSATO, Conch. Medit., p. 89, 1884.

*Turbonillas* having prominent axial ribs and spiral sculpture, but no varices or internal lirations; columella usually somewhat flexuous.

### [S. D.] Turbonilla (Pyrgiscus) auricoma *D. & B.*, sp. nov.

PLATE I, FIGS. 4 AND 4*a*.

Shell slender, attenuated, brown, lighter on the early whorls, becoming quite dark on the last; nuclear whorls two and one-half, large, helicoid, not immersed, projecting somewhat beyond the outline of the spire, their axis being at a right angle to the axis of the later whorls; post-nuclear whorls at first somewhat rounded, later flattened, traversed by eighteen to twenty-four strong, moderately wide axial ribs, inclined slightly toward the aperture; these continue quite prominently over the well-rounded periphery and base of the last whorl to the umbilical region; intercostal spaces somewhat irregular in width, deep, ornamented by about eight moderately deep, wavy, spiral striæ, which are red in color; whorls slightly contracted at base and shouldered at the summit, which is rendered wavy by the ribs; suture quite prominent; the base of the last whorl is well rounded, inflated, and ornamented by nine subequally spaced spiral striæ of a similar character to those of the

exposed portions of the whorl; aperture large, ovate, somewhat produced at the base; posterior angle acute; outer lip thin, joining the oblique, strongly revolute columella in a wide curve; the strongly reflexed columella and the decided rounding of the last whorl give the shell a subumbilicated appearance; the peritreme is rendered almost complete by the strong callus which extends from the posterior angle of the aperture to the insertion of the columella; by transmitted light the interior of the outer lip appears beautifully marked by narrow, wavy, sometimes branching, spiral threads of red, laid on a ground of pale yellow, the middle one of which is the broadest, and marks the periphery.

*Dimensions.*—Long. 7.2 mm.; diam. 1.9 mm.

The type is from Scammon's Lagoon, Lower California, and has twelve post-nuclear whorls.

This species also occurs recent along the California coast, and has been found as a post-Pliocene fossil at San Diego.

### 292. Turbonilla (Pyrgiscus) latifundia *D. & B.*, sp. nov.

PLATE III, FIGS. 5 AND 5*a*.

Shell very broadly conic, milk-white; nuclear whorls two and one-half, with moderately elevated spire, extending a little beyond the outline of the first post-nuclear whorl on one side, about one-third immersed, their axis being at a right angle to the axis of the later whorls; post-nuclear whorls well rounded, each much broader at its base than the summit, ornamented by about fourteen strong, rounded, oblique, axial ribs and seven or eight deeply impressed, very prominent spiral lirations, extending across the intercostal spaces, which are about twice as wide as the ribs, and upon the sides of these, but they do not cross their summits; both ribs and intercostal spaces pass very feebly over the decidedly angulated periphery (this angulation is much more pronounced in young specimens than in the adult); the short base is marked by about seven continuous, somewhat wavy, subequally spaced, spiral lines, much weaker than the spiral sculpture on the exposed portion of the whorls; aperture subquadrate, posterior angle acute; outer lip thin, showing the external sculpture within by transmitted light; columella straight and revolute.

*Dimensions.*—Long. 5.8 mm.; long. spir. 5.2 mm.; diam. 2 mm.

The type is a post-Pliocene fossil from San Pedro, and has nine post-nuclear whorls.

This species occurs also in the post-Pliocene deposits of Deadman Island. So far no recent representatives have been found.

### 293. Turbonilla (Pyrgiscus) tenuicula *Gould.*

PLATE II, FIGS. 7 AND 7*a*.

*Chemnitzia tenuicula* GLD., Bost. Jour. Nat. Hist., Vol. VI, 1853, pp. 383, 384, Pl. XIV, fig. 15.

Shell small, elongated, lanceolate, turreted, rather solid, shining, wax yellow, a little dusky below the suture; whorls ten, flat, slightly shouldered above, marked by about twenty direct, longitudinal folds, the summits of which are cut by numerous fine revolving striæ, deeper in the interstices, which also extend over the base of the shell, though the folds terminate at the periphery, or are extended in delicate furrows; aperture narrow, ovate; lip sharp; revolving striæ apparent within.

*Dimensions.*—Length 7.5 mm.; diam. 1.3 mm.

Found at Santa Barbara.

The above is the original description by Gould. *Turbonilla (Pyrgiscus) tenuicula* Gould is the most abundant and most variable species of all the west American forms, presenting many varieties or incipient species; to describe these would not aid science or the collector, but would only add to the confusion which this paper is intended to dispel. The following comprehensive description will embrace, we believe, all the forms coming under this name:—

Shell slender to somewhat stubby and inflated, varying in color from milk-white to waxy yellow or to dark brown, variously banded or plain monocolored; nuclear whorls three, moderately large, planorboid, slightly slantingly immersed; post-nuclear whorls rounded to flattened, contracted at base and strongly shouldered at the summit, traversed by eighteen to twenty-eight strong axial ribs, which are excurved and usually somewhat thickened, and connected at their summits, which appear beaded; these ribs extend feebly over the rounded base of the last whorl; the entire shell is crossed by spiral lines, ten to sixteen or more of which appear on the exposed portion of the whorls, and more, closer placed, wavy ones on the base of the last whorl; the suture is deep, subchanneled and wavy; aperture ovate, produced at base; outer lip thin, meeting the oblique, slightly curved and revolute columella in a broad curve; a faint callus connects the posterior angle of the aperture with the insertion of the columella.

*Dimensions.*—Long. 6.5 mm.; diam. 1.9 mm.

The specimen figured is from the Todos Santos Bay, Lower California, and has nine post-nuclear whorls. One of the same number of whorls from San Pedro measures: long. 6.2 mm; diam. 1.7 mm.

Recent specimens in our collection range from Monterey to Todos Santos Bay, Lower California. The species occurs also in the post-Pliocene beds at San Diego and San Pedro.

### 294. Turbonilla (Pyrgiscus) crebrifilata *Carpenter.*

PLATE II, FIGS. 6 AND 6*a*.

*Chemnitzia crebrifilata* CPR., Ann. Mag. Nat. Hist., 3d Ser., Vol. XV, 1865, p. 395.

Shell milk white to waxy yellow to yellowish brown in color, and of similar shape to *T. tenuicula* Gld.; nuclear whorls three, helicoid, slantingly one-third immersed; extending a little beyond the outline of the spire on one side; post-nuclear whorls at first well rounded, later flattened, strongly shouldered at the summit and ornamented by eighteen to twenty-four very pronounced, acute and somewhat flexuous, irregularly slanting axial ribs, which are outcurved at the summit of the whorl and there held in union by a spiral thickening of the wavy shoulder; intercostal spaces moderately deep and very broad, at least double the width of the ribs, with a quite deep depression immediately below the shoulder, which causes the summits of the whorls to appear crenulate, and ornamented by about eight to ten spiral striations of varied width and spacing; these striations frequently extend over the ribs and cause the intermediate ground to appear as raised ridges; suture deep and wavy; periphery and base of the last whorl well rounded, the axial ribs extending faintly over the base to the umbilical region; the base is marked by spiral striations similar to those of the exposed portion of the whorls, but here they are more wavy and adjacent; aperture ovate, rather large, acute posterior angle, and the base somewhat produced; outer lip thin, meeting the oblique, somewhat twisted and revolute columella in a gentle curve; a faint callus extends from the posterior angle of the aperture to the pillar. By transmitted light a broad, white, revolving band becomes apparent in the peripheral region of the aperture in dark-colored specimens.

*Dimensions.*—Long. 5.4 mm.; diam. 1.6 mm.

The specimen figured has nine post-nuclear whorls. Fossil specimens from the post-Pliocene of California attained a much larger size than recent representatives of the species. A fragment of a specimen collected at San Diego, consisting of the last four whorls, has a diameter of 2.2 mm.

### 295. Turbonilla (Pyrgiscus) subcuspidata *Carpenter.*

PLATE II, FIGS. 2 AND 2*a*.

*Chemnitzia subcuspidata* CPR., Proc. Cal. Acad. Sci., Vol. III, 1865, p. 220, No. 670.

Shell stout, strong, somewhat inflated, whitish to waxy yellowish; nuclear whorls three, helicoid, of moderate size, slantingly one-fourth immersed, slightly extending beyond the general outline of the spire on one side; post-nuclear whorls well rounded, the last two somewhat flattened, contracted at base, outcurved and muricated at their summits, traversed by sixteen to twenty very strong, flexuose, more or less irregular axial ribs, which extend strongly upward and render the shoulder subcuspidate and very wavy; these ribs become enfeebled on the last whorl and almost obsolete on the base, extending only very feebly over the well rounded periphery to the umbilical region; intercostal spaces wider than the ribs, undulating, traversed by five to twelve deep spiral striations, which extend less prominently over the ribs and cause the whorls to appear as if they were wound by a series of overlapping bands of varied width; these bands vary in number and consequently in width, being fewer and most prominent on the earlier whorls, as are the ribs, later on becoming enfeebled; a very slight groove passes about the periphery of the last whorl and maps out the route for the suture; the spiral sculpture of the entire last whorl is very regular, there being about thirteen subequally spaced striæ above the periphery and eighteen on the base; the sutures are very deep, subchanneled; aperture ovate; posterior angle acute; outer lip moderately thick, rather effuse at base, joining the oblique, somewhat reflexed columella in a gentle curve; a faint callus connects the posterior angle of the aperture with the insertion of the columella; by transmitted light a faint, light, revolving band becomes apparent in the peripheral region within the aperture.

*Dimensions.*—Long. 6 mm.; diam. 2 mm.

The specimen figured and described is Dr. Carpenter's type; it has eight and one-half post-nuclear whorls, and comes from San Diego. Fossil specimens from the same locality are even more robust. One of seven post-nuclear whorls measures: long. 5.6 mm.; diam. 2.1 mm. Found in the post-Pliocene deposits of San Pedro.

### Section *Pyrgisculus Monterosato.*

*Pyrgisculus* MONTEROSATO, Conch. Medit., p. 88, 1884. Type, *Melania scalaris* PHILIPPI.

*Turbonillas* with strong axial ribs and lamellate spiral sculpture, having a decidedly sloping shoulder at the summit.

### 296. Turbonilla (Pyrgisculus) laminata *Carpenter.*

PLATE II, FIGS. 8 AND 8*a*.

*Dunkeria laminata* CPR., Ann. Mag. Nat. Hist., 3rd Ser., Vol. XV, 1865, p. 396.

Shell white to dark brown, plain or variously banded; nuclear whorls three, large, tumid, helicoid, slantingly slightly immersed; post-nuclear whorls well rounded, ornamented by twenty-two to twenty-eight strong axial folds, which pass feebly over the well-rounded periphery and base of the

last whorl to the umbilical region, and five very strong, broad, flat, subequally spaced spiral ridges, which give the spire a reticulated, pitted pattern; the portions between the ribs and the spiral folds appear as small, deep pits of a more or less circular outline, while the ribs appear thickened where they are crossed by the spiral bands; a sixth spiral band maps out the path for the shoulder of the succeeding whorl on the periphery of the basal whorl, while the base proper is marked by about eight spiral striations, which are strongest at the periphery and gradually weaken toward the umbilicus; the whorls are marked by a quite prominent sloping shoulder, which extends from the first revolving band to the summit; the suture is deep, subchanneled; aperture broadly ovate, somewhat effuse, with the posterior angle acute; outer lip thin, crenulate by the spiral ridges, meeting the curved and revolute columella in a broad curve; a thin callus extends from the posterior angle of the aperture to the umbilical region.

*Dimensions.*—Long. 6.8 mm.; diam. 2.2 mm.

The specimen figured is from San Pedro, and has nine whorls.

Post-Pliocene specimens from California are usually larger, though quite identical in every other respect. One of nine post-nuclear whorls measures: long. 8.6 mm.; diam. 2.4 mm. The smallest forms come from Lower California. One of eight post-nuclear whorls measures: long. 4.9 mm.; diam. 1.6 mm.

### Section *Pyrgolampros Sacco.*

*Pyrgolampros* SACCO, I Moll. del Piedmonte e della Liguria, p. 85, 1892. Type, *P. mioperplicatulus* SACCO.

*Turbonillas* with more or less weak axial ribs, which always almost disappear as they pass over the periphery and base of the last whorl, and many very fine, faint spiral striations; columella usually somewhat flexuous.

### 297. Turbonilla (Pyrgolampros) lowei *D. & B.*, sp. nov.

PLATE I, FIGS. 5 AND 5*a*.

Shell of medium size, light golden brown; nuclear whorls three, small, helicoid, partly slantingly immersed; post-nuclear whorls very similar to those of *T. vancouverensis* Baird, in outline, moderately convex, strongly contracted at base and moderately so at the summit, bounded by a prominent suture. The early whorls increase less rapidly in diameter than the later ones, and are ornamented by more and weaker axial ribs than the later ones; these ribs slant toward the aperture; beginning with the sixth whorl the shell assumes a more robust character, the whorls become broader and are ornamented by twenty to twenty-two strong, somewhat flexuose, almost vertical axial ribs, which extend faintly over the angular periphery of the last whorl to the umbilical region; the entire shell is traversed by many very fine, very closely placed spiral striæ; aperture subrhomboid, outer lip thin, produced and flaring at its junction with the twisted and revoluted columella.

*Dimensions.*—Long. 7.2 mm.; diam. 2.2 mm.

The type is from San Pedro, and has ten and one-half whorls. Specimens from the post-Pliocene of California are larger and more robust. One of ten normal whorls measures: long. 8.1 mm.; diam. 2.4 mm. Fossil specimens occur abundantly at San Pedro and San Diego.

This species is named in honor of Mr. H. N. Lowe, of Long Beach, California, to whom we are indebted for material bearing on our study of these difficult little shells.

[S. D.] **Turbonilla (Pyrgolampros) lowei,** var. **pedroana** *D. & B.*, var. nov.

PLATE II, FIGS. 3 AND 3*a*.

Shell similar to *T. lowei*, both in general form and sculpture, but more robust, broader and less attenuate; nuclear whorls three, half immersed; post-nuclear whorls with ribs of more uniform size, not crowded and enfeebled on the early whorls as in *T. lowei;* basal portion of the whorls of a darker color than the upper, causing the exposed portion of the whorls to appear banded above the suture; whorls faintly shouldered, otherwise as in *T. lowei.*

*Dimensions.*—Long. 7 mm.; diam. 2.3 mm.

The type has nine post-nuclear whorls. Specimens from Victoria, B. C., are still broader. One of seven post-nuclear whorls measures: long. 5.5 mm.; diam. 2.1 mm. The northern specimens are also somewhat lighter in color. This variety is found living from Victoria, B. C., to San Diego, and occurs fossil in the post-Pliocene beds at San Diego.

### 298. Turbonilla (Pyrgolampros) arnoldi *D. & B.*, sp. nov.

PLATE I, FIG. 7.

Shell whitish, robust, more or less inflated; nuclear whorls decollated; post-nuclear whorls flattened, somewhat contracted at base, and slightly outcurved at the summit, traversed by about twenty-two to twenty-eight more or less irregular axial ribs, slanting slightly toward the aperture, and which extend less prominently over the well-rounded periphery of the last whorl to the umbilical region; suture deep, subchanneled, somewhat undulate; the entire surface of the whorls is covered with fine, very closely placed, wavy, spiral striations; last whorl somewhat produced; aperture large, subovate, with a thin outer lip, which is decidedly effuse at base, and meets the somewhat oblique and revolute columella in a broad curve.

*Dimensions.*—Long. 7.6 mm.; diam. 2.3 mm.

The specimen figured has eight post-nuclear whorls.

This species so far has only been reported from the post-Pliocene deposits of Deadman Island. It is named in honor of Mr. Ralph Arnold, of Pasadena, California.

### 299. Turbonilla (Pyrgolampros) gibbosa *Carpenter*.

PLATE I, FIGS. 2 AND 2*a*.

*Chemnitzia gibbosa* CPR., Cat. Maz. Shells, p. 430, No. 525, 1857.

Shell inflated, robust, broad and stumpy, of light, fulvous coloration; nuclear whorls deeply immersed, very slightly exposed at the tip, their axis apparently being at a right angle to the axis of the later whorls; post-nuclear whorls flattened, somewhat contracted at the periphery and rounded at the summit, traversed by about sixteen to twenty-four broad, coarse, irregularly slanting axial ribs, which extend over the inflated periphery of the last whorl to the umbilical region, appearing less prominent on the base; the entire surface of the shell is covered by very minute, close, spiral striation; suture subchanneled and wavy; aperture ovate, outer lip thin, joining the twisted and revolute columella in a broad curve.

*Dimensions.*—Long. 5.6 mm.; diam. 2.1 mm.

The specimen figured has seven post-nuclear whorls.

This is certainly the most unattractive member of the genus. Dr. Carpenter described it as a recent form in his Catalogue of Mazatlan Shells. We have a single recent specimen from Monterey. It appears to be more abundant in the post-Pliocene deposits of Deadman Island.

### 300. Turbonilla (Pyrgolampros) adleri *D. & B.*, sp. nov.

PLATE I, FIG. 9.

Whorls decidedly flattened, contracted at the periphery and shouldered at the summit; axial ribs only faintly indicated near the summit of the whorls by distant, shallow, impressed lines, which mark their lateral margins; the entire shell is traversed by faint, closely placed, wavy, spiral striations; suture quite deep, subchanneled; periphery of the last whorl rounded; aperture subrhomboidal, posterior angle obtuse; columella reflexed, strongly twisted, giving it the appearance of being provided with a broad, rounded fold; a faint callus connects the columella with the posterior angle of the aperture.

*Dimensions.*—Long. 9.3 mm.; diam. 3.2 mm.

Only two fragments of this specimen have so far come to our notice; both are from the post-Pliocene deposits of Deadman Island.

The type consists of the last six post-nuclear whorls. It may, however, have had eleven whorls normally.

### Genus **Pyramidella** *Lamarck.*

Shell turriculated, spire elevated, axially ribbed; columella with three anterior plications; outer lip sharp, sometimes plicate within.

*Pyramidella plicata* Lamarck is a characteristic species.

### 301. Pyramidella conica *Adams*, var. variegata *Carpenter.*

*Obeliscus variegata* CPR., Brit. Assn. Rept., 1863, p. 658; Ann. Mag. Nat. Hist., 3rd Ser., Vol. XIV, 1864, p. 46. KEEP, West Coast Shells, p. 54, fig. 35, 1892.

*Pyramidella conica* ADS., var. *variegata* CPR., WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 208.

Shell small, elongate-conical; spire elevated; apex acute; whorls ten, flat, smooth; suture distinct; aperture subovate; outer lip thin; columella truncated, with three plications.

*Dimensions.*—Long. 13 mm.; lat. 3.6 mm.; defl. 20 degrees.

Rare in upper San Pedro series of San Pedro; one specimen. This species was omitted from the text prepared by Dall and Bartsch. In examining some *Turbonillas* in the collection of Mr. Henry Hemphill the writer found one of this species labeled "*Turbonilla mexicana* Dall and Bartsch." This name is the one under which it probably should appear, but not having an opportunity to consult Dr. Dall on the subject, this note is appended.

*Living.*—San Diego; Lower California (Carpenter).

*Pleistocene.*—San Pedro (Arnold).

## Genus **Odostomia** *Fleming.*

*Odostomia* FLEMING, Edinburgh Encyclopedia, Vol. VII, Pt. I, p. 76, 1817 ? (*ex parte*).
Type, *Odostomia plicata* MONT.

Shell with sinistral nucleus, subglobose to broadly conic; spire rarely elevated as in *Turbonilla*; sculpture varying in the different sections from plain (*Odostomia*, s. s.) to highly ornamented (*Chrysallida*); columella provided with a single fold, which is rarely obsolete.

Animal as in *Turbonilla*. The species of this genus are distributed in all seas. The original description of this genus included chiefly small land shells, with dentate apertures, but also a few marine species. The land shells had already received names, so the marine species were left to carry Fleming's name, a fact recognized by him in later publications. The rarity of the original edition of the Edinburgh Encyclopedia has made it very difficult to ascertain the facts in regard to this genus, and the true date of its publication, but we believe the facts to be now established as above stated. The species cited in the original publication are *O. interstincta*, *O. unidentata*, *O. plicata*, *O. sandvicensis* and *O. insculpta*.

### Section *Odostomia Fleming, s. s.*

*Odostomia* FLEMING, Edinburgh Encyclopædia, Vol. VII, Pt. I, p. 76, 1817 (*ex parte*).
Type, *Odostomia plicata* MONT.

*Odostomias* of more or less conical outline, devoid of all sculpture, except incremental lines, and having a more or less prominent columellar fold.

### 302. **Odostomia tenuis** *Carpenter.*

PLATE I, FIG. 14.

*Odostomia tenuis* CPR., Cat. Maz. Shells, p. 412, 1856.

Shell slender, conic, umbilicated, dingy white; nuclear whorls small, immersed; post-nuclear whorls very slightly convex, almost flattened, scarcely contracted at base, and hardly shouldered; suture not very prominent, hardly channeled; base and periphery of the last whorl well rounded; aperture quite large, ovoid, posterior angle acute, outer lip somewhat contracted at its middle; columella very flexuous, slender and revolute; parietal wall covered by a faint callus; columellar fold strong opposite the umbilical chink.

*Dimensions.*—Long. 5.7 mm.; diam. 2.6 mm.

The specimen figured is from Santa Rosa Island, California, and has seven post-nuclear whorls.

The species appears to range in the recent state from Washington to California, and has been found in the post-Pliocene deposits of San Diego, San Pedro, and Ventura.

### Section *Evalea A. Adams.*

*Evalea* A. ADAMS, Ann. Mag. Nat. Hist., 3d Ser., Vol. VI, 1860, p. 22. Type, *Odostomia (Evalea) elegans* A. ADAMS.

*Ondina* DE FOLIN, Fonds de la Mer, p. 214, 1870. Type, *Ondina sulcata* DE FOLIN, l. c.

*Odostomias* without axial sculpture, having spiral striation or liration.



March 31, 1903.

[S. D.] **Odostomia (Evalea) stearnsii** *D. & B.*, sp. nov.

PLATE I, FIG. 12.

Shell regularly elongate-conic, turreted, subumbilicated, milk white; nuclear whorls small, slantingly immersed; post-nuclear whorls rounded, somewhat contracted at base and strongly shouldered at the summit; suture profound, channeled; last whorl rather inflated; aperture large, pyriform, posterior angle obtuse, outer lip slightly contracted at the middle; columella decidedly oblique, flexuous and reflexed, the narrow parietal wall being covered by a faint callus; a weak columellar fold appears opposite the umbilical chink; the entire shell is ornamented with very fine spiral striation.

*Dimensions.*—Long. 5.2 mm.; diam. 2.2 mm.

The type has eight post-nuclear whorls, and is from the post-Pliocene of San Diego, which is the only locality, so far, from which this species has been reported.

### 303. Odostomia (Evalea) gouldii *Carpenter.*

PLATE I, FIG. 15.

*Odostomia* (? var.) *gouldii* CPR., Ann. Mag. Nat. Hist., 3rd Ser., Vol. XV, 1865, p. 30.

Shell solid, inflated, shining, subdiaphanous to milk-white; nuclear whorls obliquely immersed; post-nuclear whorls rounded, not contracted at base, and but very feebly shouldered at the summits; base and periphery of the last whorl well rounded; aperture large, ovoid, posterior angle acute; outer lip well rounded, its anterior margin somewhat effuse at the junction with the twisted, reflexed and appressed columella; columellar fold very prominent a little anterior to the upper end of the columella; the entire shell is very feebly and closely spirally striated.

*Dimensions.*—Long. 5 mm.; diam. 2.8 mm.

The specimen figured has six post-nuclear whorls, and comes from Monterey. The species ranges recent from Alaska to San Diego, Cal., occurring as a post-Pliocene fossil in the last-named place, and also at San Pedro and Ventura.

### Section *Amaura Möller.*

*Amaura* MÖLLER, Index Moll. Grœnl., p. 7, 1842. Type, *A. candida* MÖLLER, l. c.

*Odostomias* of extremely large size, inflated, very heavy, usually devoid of all sculpture, sometimes very minutely spirally striated.

This genus was supposed to be naticoid, but an examination of the authentic specimens shows its relations to be with the Pyramidellidæ. The account of the animal in Fischer's Manual appears to have been taken from a true naticoid, perhaps *Amauropsis*, which Fischer wrongly includes as a section under *Amaura*; but this account does not agree with Möller's original diagnosis, nor with the characters of *Amaura*, as determined from specimens collected in Greenland by Möller, which show, when the back of the shell is ground away, the plait invisible from in front of the aperture.

### [S. D.] Odostomia (Amaura) pupiformis *Carpenter.*

PLATE I, FIG. 13.

*Odostomia satura* var. *pupiformis* CPR., Ann. Mag. Nat. Hist., 3rd Ser., Vol. XV, 1865, p. 30.

Shell broadly conic, umbilicated, rather thin, white, shining, of rather rough exterior; nuclear whorls immersed; post-nuclear whorls somewhat rounded and shouldered at the summit; suture deep and channeled; base and periphery of the last whorl decidedly rounded; aperture large, broadly ovate; posterior angle acute; outer lip somewhat effuse in its anterior margin; columella thin and flexuose, provided with a prominent oblique fold a little anterior to the umbilicus; a weak callus covers the parietal wall.

*Dimensions.*—Long. 6.4 mm.; diam. 3.3 mm.

The type was collected at Neeah Bay, Washington, and has six post-nuclear whorls. The strong umbilication and the light weight of the shell enable one to distinguish it quite readily from all the other forms of this section. The species ranges recent from Alaska to San Diego. Fossil specimens have been found in the post-Pliocene beds of San Diego.

### 304. Odostomia (Amaura) nuciformis, var. avellana *Carpenter.*

PLATE I, FIG. 11.

*Odostomia* (? var.) *avellana* CPR., Ann. Mag. Nat. Hist., 3rd Ser., Vol. XV, 1865, p. 30.

Shell large, stout and inflated, white; nuclear whorls small, immersed; post-nuclear whorls somewhat rounded, rather broad, marked only by thin lines of growth; sutures quite prominent, subchanneled; base and periphery of the last whorl well rounded; aperture large, subovate; posterior angle obtuse; outer lip somewhat contracted, while the anterior margin is somewhat effuse; columella short and flexuose, provided with a strong, broad fold just anterior to the umbilical chink; a strong callus extends from the posterior angle of the aperture to the base of the columella and renders the peritreme almost continuous.

*Dimensions.*—Long. 9.1 mm.; diam. 4.4 mm.

This is one of the large West Coast *Odostomias*, and ranges in the recent state from Alaska to San Pedro. The specimen figured is from Neeah Bay, Washington, the type locality. It has six post-nuclear whorls.

Fossil forms occur in the post-Pliocene deposits of Deadman Island, and also at Ventura.

*O. avellana* differs from true *O. nuciformis* in having the spire much more elongated; it is therefore less pudgy than that form.

### Section *Chrysallida Carpenter.*

*Chrysallida* CPR., Cat. Maz. Shells, p. 416, 1857. Type, *Chrysallida communis* C. B. ADAMS.

*Odostomias* having strong axial ribs, crossed by equally strong spiral sculpture, which renders the spire nodulose; the axial ribs pass only faintly over the base, while the spiral sculpture remains quite prominent.

### [S. D.] **Odostomia (Chrysallida) diegensis** *D. & B.*, sp. nov.

PLATE I, FIG. 8.

Shell elongate-conic, dingy white; nuclear whorls decollated; post-nuclear whorls flattened, contracted at base and strongly shouldered at the summit; suture undulate, profoundly channeled; about seventeen very strong, rounded, axial ribs cross the third and fourth, and twenty-two the penultimate whorl; these ribs pass faintly over the well-rounded periphery of the last whorl to the umbilical region; the first five whorls are encircled by four strong, spiral ridges, while the penultimate shows an additional one; these ridges are not quite as broad as the axial ribs, but extend prominently over them and the intercostal spaces; base ornamented by about ten spiral ridges of weaker character than those of the spire, and by the faint extensions of the axial ribs; aperture suboval, decidedly produced and flaring at the junction of the outer lip with the columella (outer lip fractured in all our specimens); columella somewhat twisted and reflexed, a bit being broken away at the umbilical region in the type, disclosing a small umbilical chink which is opposite to the strong columellar fold; a heavy callus connects the posterior angle of the aperture with the columella.

*Dimensions.*—Long. 4 mm.; diam. 1.6 mm.

The seven specimens of this species in our collection all come from the post-Pliocene deposits at San Diego. The type has seven post-nuclear whorls.

### Section *Oscilla A. Adams.*

*Oscilla* A. ADAMS, Proc. Zool. Soc., 1867, p. 310. Type, *Odostomia* (*Evalea*) *lirata* A. AD.

*Odostomias* having strong spiral ribs, the spaces between which are ornamented by numerous fine, raised, axial threads.

### [S. D.] **Odostomia (Oscilla) æquisculpta** *Carpenter.*

PLATE I, FIGS. 3 AND 3*a*.

*Odostomia (Evalea) æquisculpta* CPR., Ann. Mag. Nat. Hist., 3d Ser., Vol. XIV, 1864, pp. 46, 47.

Shell small, quite solid, elongate-ovate, subdiaphanous to white; nuclear whorls three, obliquely one-third immersed; post-nuclear whorls rounded, separated by a prominent suture and ornamented by about five fairly strong and rounded, subequally spaced spiral ridges on the second, and six above the periphery on the penultimate whorl; the base of the last whorl is similarly sculptured, the striations becoming fainter near the columella; the depressed spaces between the revolving ridges are beautifully, closely crossed by fine axial riblets; periphery of the last whorl well rounded; aperture large and effuse at base, posterior angle acute, outer lip thin, somewhat arcuate; columella stout, provided with a small fold near the umbilical chink; a faint callus unites the posterior angle of the aperture with the upper end of the columella; the external sculpture is apparent within the aperture by transmitted light.

*Dimensions.*—Long. 2 mm.; diam. 1.2 mm.

The specimen here described and figured is Dr. Carpenter's type. It was collected at Cape St. Lucas, Lower California.

This species occurs quite abundantly as a recent form, ranging from San Pedro, California, to Cape St. Lucas. It is also found in the post-Pliocene deposits of San Diego.

The type is an immature specimen. One specimen comprising seven post-nuclear whorls measures: long. 5 mm.; diam. 1.8 mm.

[S. D.] **Odostomia (Oscilla) grammatospira** *D. & B.*, sp. nov.

PLATE I, FIGS. 6 AND 6*a*.

Shell elongate-conic, subdiaphanous to milk white; nuclear whorls three, one-half obliquely immersed; post-nuclear whorls flattened, traversed by four very strong, flattened, decidedly raised spiral ridges, which are separated by furrows of about the same width; the sutures being marked by a little wider groove than those between the spiral ridges; the spiral depressions are very finely and closely axially ribbed; the base of the last whorl is ornamented by similar sculpture, but of a weaker character, the spiral ridges diminish gradually in size and at the same time approach each other more closely, vanishing altogether on the extreme base; aperture subrhombic, posterior angle acute, outer lip thin, arcuate, very much produced and flaring at the junction with the pillar; columella stout, reflexed, provided with a prominent fold at its insertion.

*Dimensions.*—Long. 5.3 mm.; diam. 2.1 mm.

The type has eight post-nuclear whorls. It was collected at Cape St. Lucas, Lower California. Two fossil specimens in our collection from the post-Pliocene beds of San Diego are referable to this species.

Subgenus **Ivara** *D. & B.* (mss.)

*Odostomias* characterized by the spiral striation and tabulated whorls.

**305. Odostomia (Ivara) terricula** (*Carpenter*) *D. & B.*

PLATE IV, FIG. 14.

*Ivara terricula* CPR. (mss.), D. & B., 1901.

Shell minute, ovate, thin; spire elevated; apex acute; whorls five, convex, shouldered above; surface sculptured by fine, spiral ridges and obsolete transverse ribs, more prominent near top of whorls; suture deeply impressed; body-whorl over half length of shell; shouldered above, evenly convex below; aperture truncated above, evenly rounded below; outer lip thin, extending around and up on columella, forming a small columellar plication.

*Dimensions.*—Long. 4 mm.; lat. 1.8 mm.; body-whorl 2.6 mm.; aperture 1.5 mm.

This delicate little shell is easily recognized by its shouldered whorls and delicate spiral sculpture. Specimen identified by Dr. Dall; but the species omitted from the text prepared by Dall and Bartsch.

Rare in lower San Pedro series of Deadman Island. One specimen, which is figured, and is now in the collection of Delos Arnold.

*Living.*—Mexican Coast (Dall).

*Pleistocene.*—San Pedro (Arnold).

## Superfamily TÆNIOGLOSSA.

## Family LXV. TRITONIDÆ.

### Genus **Tritonium** *Link.*

Shell oblong; spire prominent; whorls with a few remote and non-continuous varices; columella rough or smooth; canal recurved, short or long; outer lip internally crenated or denticulated.

*Tritonium variegatus* Lam. is a characteristic species.

### 306. Tritonium gibbosus *Broderip.*

*Triton gibbosus* BROD., Proc. Zool. Soc., 1833, p. 7, Pl. VII. KUSTER, Conch. Cab., p. 69, fig. 7. TRYON, Man. Conch., Vol. III, p. 23, Pl. XII, fig. 103, 1881. COOPER, Bull. No. 4, Cal. St. Min. Bureau, Part III, 1894, p. 32.

Shell small, subfusiform; whorls five, subtriangular, strongly angulated, giving tabular appearance to the upper part of whorls; prominent rounded, nodose varices at about every two-thirds of a revolution, with two or three nodes on angle of whorl in intervening spaces; suture reaching nearly to columella, giving a staircase appearance to the spire; surface ornamented with small, revolving ridges made rugose by incremental lines; aperture subcircular; outer lip slightly corrugated internally; inner lip smooth, incrusted; canal long, narrow, curved slightly back; umbilicus subperforate.

*Dimensions.*—Long. 41 mm.; lat. 22 mm.; body-whorl 28 mm.; aperture 10 mm.; canal 11 mm.; defl. 56 degrees.

A unique shell, the only one of its genus so far recorded as occuring fossil in California.

Rare in upper San Pedro series of San Pedro; one specimen found. Dr. Dall also reports one found in the bay at this place, which he thinks is a fossil that had been weathered out of the Pleistocene beds.

*Living.*—West tropical America; Panama (Cooper).

*Pleistocene.*—San Pedro (Dall; Arnold).

### Subgenus **Priene** *H. & A. Adams.*

Shell ventricose, thin, cancellated or plicated; canal short; operculum with apical initial point.

### 307. Tritonium (Priene) oregonensis *Redfield.*

PLATE VI, FIG. 1.

*Triton oregonense* REDF., Ann. N. Y. Lyc., Vol. IV, 1846, p. 165, Pl. XI, figs. *2a, 2b.* GLD., Wilkes' Expl. Exped., Vol. XII, p. 241, 1852.
*Fusus oregonensis* REDF., REEVE, Icon. Conch., No. 61, figs. 61*a-b*, 1848.
*Triton (Priene) oregonensis* REDF., CPR., Brit. Assn. Rept., 1863, p. 661.
*Tritonium (Priene) oregonensis* REDF., GABB, Pal. Cal. Vol. II, p. 73, 1869.
*Tritonium oregonense* REDF., DALL, Proc. U. S. Nat. Mus., Vol. IX, 1887, p. 212.
*Priene oregonensis* REDF., COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 261. KEEP, West Coast Shells, p. 44, 1892.
*Priene cancellatus* LAM. (*fide* TRYON, Man. Conch., Vol. III, p. 34, Pl. XVI, figs. 164-167; Pl. XVII, figs. 170-172, 1881) (pars).

Shell large, fusiform; spire elevated; apex blunt; whorls eight to ten, convex; nuclear whorls smooth, except for obsolete spiral striations; cancellated sculpture of nearly equally prominent spiral and transverse rounded ridges; suture deeply impressed; discontinuous rounded varices at every half to two-thirds revolution on upper whorls; aperture subovate; outer lip not thickened, slightly effuse on adult shells; canal long, narrow, recurved; inner lip incrusted; columella slightly twisted; umbilicus obsolete.

*Dimensions.*—Long. 103 mm.; lat. 48.5 mm.; body-whorl 71 mm.; aperture 31 mm.; canal 21 mm.; defl. 47 degrees.

Young shells look much like certain species of *Triton* on account of varices. Common in the Pliocene of Deadman Island; rarer in the lower San Pedro series at Deadman Island, and only occasionally found in the upper San Pedro series at Deadman Island, San Pedro, and Crawfish George's. The specimen figured is from the Pliocene of Deadman Island, and is now in the collection of Delos Arnold.

*Living.*—Straits of Fuca to Monterey; Japan (Cooper): dredged off San Diego (Raymond): Kodiak Island (Snodgrass).

*Pleistocene.*—Santa Barbara; San Pedro (Cooper): San Pedro (Arnold).

*Pliocene.*—San Pedro (Arnold).

### Genus **Ranella** *Lamarck.*

Shell ovate or oblong, compressed, with two rows of continuous varices, one on each side; aperture oval; columella arcuated and ridged, or crenulated; canal short, recurved; outer lip crenated.

*Ranella spinosa* Lam. is a characteristic species.

### 308. **Ranella californica** *Hinds.*

*Ranella californica* HDS., Ann. Nat. Hist., Vol. II, 1843, p. 255; Voyage Sulphur, p. 12, Pl. II, figs. 3 and 5, 1844. CPR., Brit. Assn. Rept., 1863, p. 661. TRYON, Man. Conch., Vol. III, p. 40, Pl. XXI, fig. 32; Pl. XXII, fig. 42, 1881. GABB, Pal. Cal., Vol. II, p. 73, 1869. KEEP, West Coast Shells, p. 44, fig. 24, 1892. WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 211.

Shell large, broadly fusiform; spire elevated, about one-half length of aperture; whorls five, convex, each with two prominent, rounded, rather reflexed varices, each set forming a continuous varix from apex to base; between varices are one or two prominent rows of rounded nodes, each row having from one to four, and numerous rugose revolving ridges of varying prominence; suture deeply impressed, distinct; aperture subovate; outer lip thickened, ridged, denticulated; inner lip incrusted, the spiral ornamentation sometimes showing through the incrustation; columella curved, flattened, widened; canal short.

*Dimensions.*—Long. 90 mm.; lat. 67 mm.; body-whorl 70 mm.; aperture, including canal, 53 mm.; defl. 76 degrees.

This shell is easily distinguishable by its size and general solid appearance. Rare in the upper San Pedro series of San Pedro; three perfect specimens found; one fine specimen from the upper San Pedro series of Los Cerritos; also found at Deadman Island and Crawfish George's in the same horizon. Found in the Pleistocene at Pacific Beach, San Diego.

*Living.*—Santa Barbara to Lower California (Carpenter).

*Pleistocene.*—Santa Barbara; San Pedro (Gabb): San Pedro; San Diego (Arnold).

*Pliocene.*—Kirker's Pass.

## Family LXVI. CYPRÆIDÆ.

### Genus **Cypræa** *Linné.*

Shell ventricose, convolute, covered with shiny enamel; spire concealed; aperture long and narrow, with a short canal at each end; inner lip crenulated; outer lip inflected and crenulated.

*Cypræa argus* Linn. is a characteristic species.

#### 309. **Cypræa spadicea** *Gray.*

*Cypræa spadicea* SWAINSON, Tillock's Phil. Mag., Vol. LXI, 1823, p. 376; Exotic Conchology, Pl. CLXXXII. TRYON, Man. Conch., Vol. VII, p. 182, Pl. XIII, fig. 78, 1885.

*Cypræa spadicea* GRAY, Monog. Cypræidea, Zool. Jour., London, Vol. I, 1824, p. 71. DALL, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 207.

*Luponia spadicea* GRAY, CPR., Brit. Assn. Rept., 1863, p. 657. KEEP, West Coast Shells, p. 59, fig. 43, 1892.

*Luponia spadicea* SWAIN., GABB, Pal. Cal., Vol. II, p. 78, 1869. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 247.

Shell of medium size, pyriform, ventricose, convolute; spire concealed; surface covered with shining reddish brown enamel in living shell (in the fossil obtained at San Pedro this is worn and subdued); aperture long and narrow, with a short canal at each end, the anterior canal being the longer; outer lip inflected and crenulated; inner lip crenulated.

*Dimensions.*—Long. 50 mm.; lat. 33 mm.; altitude, when lying aperture down, 25 mm.

Specimen identified by Dr. Dall.

One specimen from the upper San Pedro series of Deadman Island found by Mrs. Oldroyd, and one from the upper San Pedro series at the lumber yard, San Pedro, found by Delos Arnold.

*Living.*—Santa Barbara to San Diego and Lower California (Cooper).

*Pleistocene.*—Santa Barbara Island (Cooper): San Pedro (Oldroyd; Arnold).

### Genus **Trivia** *Gray.*

Small shells with striæ extending over the back, where they are frequently interrupted by an impressed dorsal sulcus.

*Trivia quadripunctata* Gray is a characteristic species.

#### 310. **Trivia californica** *Gray.*

*Trivia californica* Gray, CPR., Brit. Assn. Rept., 1863, p. 657. KEEP, West Coast Shells, p. 60, figs. 44, *a*, *b*, 1892. WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 207.

Shell small, semiglobular; convex surface crossed by eight or nine transverse ridges, which are interrupted on the center of the shell by a slight depression running longitudinally; sloping surface of ends ornamented with several ridges that radiate from the ends of the dorsal depression; aperture narrow, curved; outer and inner lip denticulated by elongated, sharp teeth, the continuations of the transverse ridges.

*Dimensions.*—Long. 8 mm.; lat. 6.5 mm.; alt. 5 mm.

Only a few specimens found in the upper San Pedro series of San Pedro.

*Living.*—Santa Barbara to Lower California (Carpenter).

*Pleistocene.*—San Pedro (Arnold).

### 311. Trivia solandri *Gray.*

*Trivia solandri* GRAY, CPR., Brit. Assn. Rept., 1863, p. 657. KEEP, West Coast Shells, p. 60, 1892. WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 207.

Shell, small, ventricose, convolute; spire concealed; about thirteen elevated lines cross the back of the shell; these lines are interrupted in the middle of the shell by an impressed median sulcus, along the sides of which the transverse lines end in rounded nodes; the sulcus does not extend to either end of the shell; aperture long and narrow, with a canal at each end; inner lip crenulated; outer lip inflected and crenulated.

*Dimensions.*—Long. 12.5 mm.; lat. 9.5 mm.; height, when lying on aperture, 7 mm.

This species is distinguishable from *T. californica* by its much larger size, coarser sculpture and impressed median sulcus.

One specimen from the lower San Pedro series of Deadman Island.

*Living.*—Santa Barbara to Panama (Carpenter).

*Pleistocene.*—San Pedro (Arnold).

## Genus **Erato** *Risso.*

Shell obovate, polished; spire short, conical, distinct; aperture linear; outer lip without varix, but thickened toward the middle, and denticulated within; columella with distinct plates at the forepart.

*Erato lævis* Donov. is a characteristic species.

### 312. Erato columbella *Menke.*

*Erato columbella* MKE., Zeit. Mal., p. 183, No. 26, 1847. CPR., Brit. Assn. Rept., 1863, p. 657. TRYON, Man. Conch., Vol. V, p. 10, Pl. IV, fig. 8, 1883. KEEP, West Coast Shells, p. 61, fig. 46, 1892. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 240. WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 207.

Shell small, pyriform; spire only slightly elevated; whorls four, nearly flat, except body-whorl, which is ventricose and pyriform, and comprises most of the shell; surface smooth; suture distinct; aperture long, narrow, curved around body-whorl; outer lip finely dentate within.

*Dimensions.*—Long. 7 mm.; lat. 4 mm.; body-whorl 6.5 mm.; aperture 6 mm.

One specimen from upper San Pedro series of San Pedro.

*Living.*—Monterey to San Diego; Mazatlan (Cooper).

*Pleistocene.*—Santa Barbara (Cooper): San Pedro (Arnold).

## Family LXVII. TRIFORIDÆ.

### Genus **Triforis** *Deshayes.*

Shell sinistral, sculptured, granular; whorls numerous, terminating below in a small aperture, with tubular anterior canal; opposite this canal is sometimes a second one upon a varix, marking the position of a former aperture.

*Triforis perversus* Linn. is a characteristic species.

#### 313. **Triforis adversa** *Montagu.*

*Triforis adversa* MONT., Test. Brit., p. 271, 1803. CPR., Brit. Assn. Rept., 1863, p. 660. TRYON, Man. Conch., Vol. IX, p. 187, Pl. XXXIX, fig. 51, 1887. KEEP, West Coast Shells, p. 47, 1892.

Shell sinistral, with cancellated sculpture, caused by three spiral and numerous equally as prominent transverse ridges; resembles *Bittium rugatum* somewhat in sculpture.

One imperfect specimen from lower San Pedro series at Deadman Island collected by Mrs. Oldroyd.

*Living.*—Vancouver to Santa Barbara Island (Carpenter).

*Pleistocene.*—San Pedro (Oldroyd).

## Superfamily CERITHIACEA.

## Family LXVIII. CERITHIOPSIDÆ.

### Genus **Seila** *A. Adams.*

Shell spiral, elongated, many whorled, frequently varicose; aperture channeled in front, with a less distinct canal posteriorly; outer lip not reflected; nuclear whorls sinistral; transversely lirate.

#### 314. **Seila assimilata** *C. B. Adams.*

PLATE IV, FIG. 8.

*Cerithiopsis assimilata* C. B. AD., Maz. Cat., No. 563, 1852. CPR., Brit. Assn. Rept., 1863, p. 660. TRYON, Man. Conch., Vol. IX, p. 174, Pl. XXXVI, fig. 59, 1887. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 232. KEEP, West Coast Shells, p. 48, 1892.

Shell small, thin, turreted; nuclear whorls sinistral; whorls ten, ornamented with three prominent, sharp, equal, equidistant, raised spiral lines; interspaces between ridges crossed by numerous fine lirulæ; suture indistinct, not distinguishable on upper portion of spire; base truncated abruptly, flat; aperture subquadrate; outer lip thin, not effuse; inner lip simple; columella recurved; canal short.

*Dimensions.*—Long. 10 mm.; lat. 3.8 mm.; body-whorl 3.8 mm.; aperture 2.1 mm.; defl. 24 degrees.

Resembles the *Bittiums*, but is distinguishable by the strong spiral lines. Specimen identified by Dr. Dall. Rare in lower San Pedro series at San Pedro.

The specimen figured was obtained from the lower San Pedro series at San Pedro, and is now in the private collection of Delos Arnold.

*Living.*—Monterey to Panama (Cooper): Catalina Island, 20 fathoms (Arnold, 1901).

*Pleistocene.*—San Pedro (Oldroyd; Arnold): San Diego (Cooper).

## Family LXIX. CERITHIIDÆ.

### Genus **Bittium** *Leach.*

Shell elevated, with numerous granular whorls and irregular varices; anterior canal short, not recurved; inner lip simple; outer lip not reflected, usually with an exterior rib.

*Bittium reticulatum* Da Costa is a characteristic species.

### 315. **Bittium asperum** *Gabb.*

*Turbonilla aspera* GABB, Proc. Phil. Acad. Nat. Sci., 1861, p. 368.
*Bittium asperum* GABB, CPR., Ann. & Mag. Nat. Hist., 3rd Ser., Vol. XVII, 1866, p. 276. GABB, Pal. Cal., Vol. II, p. 72, Pl. II, fig. 20, 1869. TRYON, Man. Conch., Vol. IX, p. 153, Pl. XXX, fig. 7, 1887. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 230.
*Bittium asperum* CPR., WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 205.

Shell small, slender, turreted; apex elevated, acute; whorls nine to ten, nearly flat on posterior portion, with prominent angulation anteriorly; sculpture consists of three spiral ridges, crossed by sixteen to eighteen much more prominent ridges; suture deep, distinct; aperture semi-elliptical, with prominent basal emargination instead of a canal; lip thin, inner side crenulated; body-whorl angulated, base slightly sculptured spirally.

*Dimensions.*—Long. 10.5 mm.; lat. 31 mm.; aperture 2.5 mm. x 1.5 mm.; defl. 22 degrees.

This species may be distinguished by the relative prominence of its transverse sculpture. Specimens identified by Dr. Dall

Common in the Pliocene at Deadman Island and Timm's Point; rare in the lower San Pedro series of Deadman Island, and found only occasionally in the upper San Pedro series of Crawfish George's and San Pedro. Found in the Pleistocene at bath-house, Santa Barbara; at Barlow's ranch, Ventura; and at Pacific Beach, San Diego.

*Living.*—Santa Barbara to Catalina Island (Cooper).

*Pleistocene.*—Santa Barbara to San Diego (Cooper): San Pedro; Ventura; Santa Barbara; San Diego (Arnold).

*Pliocene.*—San Diego well (Dall): San Pedro (Arnold).

### 316. **Bittium californicum** *Dall & Bartsch.*

PLATE IV, FIG. 4.

*Bittium (Elachista) californicum* DALL & BARTSCH, Nautilus, Sept., 1901, p. 58.

Shell, small, thin, white, turreted; spire elevated, mammilliform apex; whorls eight, convex, slightly more angular on anterior portion of whorl; whorls crossed by twelve or thirteen prominent,

rounded, equal, equidistant ridges; spiral sculpture hardly visible; suture deeply impressed, distinct; aperture subrotund; outer lip thin, smooth; columella smooth; body-whorl angulated at the base; base shows spiral lines.

*Dimensions.*—Long. 6 mm.; lat. 2.2 mm.; body-whorl 2.5 mm.; aperture 1 mm.; defl. 24 degrees.

This species, with the possible exception of *B. williamsoni*, is the smallest of the Pleistocene *Bittiums* of this locality, and is easily distinguishable by its size and the faintness of its spiral sculpture. Several specimens show a slightly less deflection than the one figured. Specimen identified by Dr. Dall.

Rare in the lower San Pedro series at San Pedro. The specimen figured, which was found in the lower San Pedro series at San Pedro, is now in the collection of Delos Arnold.

*Pleistocene.*—San Pedro (Arnold).

### 317. Bittium filosum *Gould.*

*Cerithium filosum* GLD., Proc. Bost. Soc. Nat. Hist., Vol. III, 1849, p. 120; Wilkes' Expl. Exped., Vol. XII, p. 149, fig. 175, 1852.

*Bittium filosum* GLD.. CPR., Brit. Assn. Rept., 1863, p. 655. TRYON, Man. Conch., Vol. IX, p. 152, Pl. XXIX, fig. 90, 1887. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 230. KEEP, West Coast Shells, p. 72, fig. 57, 1892.

Shell small, slender, turreted; apex elevated, acute; whorls eight, flat, slightly angulated near anterior margin, and ornamented with four alternating ridges and grooves of about equal width; apical whorls transversely sculptured; base of body-whorl sculptured in same way; suture deep, distinct; aperture small, semielliptical, with basal emargination instead of a canal; lip thin, with interior ridges corresponding to exterior grooves.

*Dimensions.*—Long. 8.5 mm.; lat. 2.9 mm.; aperture 2 mm. x 1.2 mm.; defl. 20 degrees.

This species is distinguishable by its lack of transverse ornamentation. The specimen described was identified by Dr. Dall.

Specimens of this species are rather rare in both the lower and upper San Pedro series at San Pedro and Deadman Island; a few found at Crawfish George's.

*Living.*—Sitka to Monterey (Cooper).

*Pleistocene.*—Santa Barbara (Cooper): San Pedro (Arnold).

### 318. Bittium quadrifilatum *Carpenter.*

PLATE IX, FIG. 2.

*Bittium quadrifilatum* CPR., Brit. Assn. Rept., 1863, p. 655; Jour. de Conch., Vol. XII, 1865, p. 143. TRYON, Man. Conch., Vol. IX, p. 153, Pl. XXIX, fig. 91, 1887. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 230. KEEP, West Coast Shells, p. 72, 1892. WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 205, Pl. XXI, fig. 4.

Shell small, turreted, elongate; apex acute; whorls ten or eleven, nearly flat; body-whorl slightly ventricose; surface sculptured by four more or less prominent spiral ridges, and on upper whorls by transverse ridges; these ridges become obsolete on the penultimate and body-whorls in adult specimens, leaving only the spiral lines on these whorls; suture distinct, impressed, giving a

keeled appearance to the lower portion of the whorl in some specimens; aperture subquadrate; outer lip thin; columella truncate, spirally sculptured without.

*Dimensions.*—Long. 10 mm.; lat. 2.5 mm.; defl. 18 degrees.

This species is intermediate between *B. filosum* and *B. asperum*, having the sculpture of the former on the body-whorl and the sculpture of the latter on the apical whorls, while the intermediate whorls have a gradation sculpture. Specimens identified by Dr. Dall.

Not uncommon in the lower San Pedro series at Deadman Island and San Pedro; rare in the upper San Pedro series at Deadman Island, San Pedro, Los Cerritos, and Crawfish George's. Found in the Pleistocene at the bath-house, Santa Barbara.

The specimen figured is from the lower San Pedro series at Deadman Island, and is now in the collection of Delos Arnold.

*Living.*—Monterey to San Diego (Cooper).

*Pleistocene.*—Santa Barbara (Cooper): San Pedro; Santa Barbara (Arnold).

One of the laws of evolution is that of acceleration of development, which has been formulated by Alpheus Hyatt,[1] as follows:—

"All modifications and variations in progressive series tend to appear first in the adolescent or adult stages of growth, and then to be inherited at earlier and earlier stages, according to the law of acceleration, until they either become embryonic or are crowded out of the organization, and replaced in the development by characters of later origin."

This means that theoretically each organism in its ontogeny, or life history, ought to go through stages of growth corresponding to all of its ancestors, and that these stages ought to appear in the order of its ancestral forms. This law is exemplified by the genetic series, consisting of *B. asperum*, *B. quadrifilatum* and *B. filosum*.

First, we have *B. asperum*, which is the only species of this genus found in the Pliocene at Deadman Island. It has a characteristic nodose-cancellate sculpture, caused by two series of ridges, spiral and transverse, and this sculpture extends back from the body-whorl through the intermediate to the apical whorls. Thus, in this species the same characteristic sculpture is found in the larval stage (which is represented by the apical whorls), the adolescent stage (intermediate whorls), and in the adult stage, which is represented by the penultimate and body-whorls.

Next we have *B. quadrifilatum* (Plate IX, fig. 2), which is first found in the lower San Pedro beds of the Pleistocene, and which, it is reasonable to suppose, developed out of *Bittium asperum*. At any rate, this species is not found in the Pliocene, but is quite abundant in the lower San Pedro. The sculpture of this species is as follows: Apical whorls nodose-cancellate; intermediate whorls with the transverse sculpture becoming less prominent as the whorls become larger; penultimate and body-whorl generally with four prominent spiral threads or ridges, but with

[1] A. Hyatt, "Genesis of the Arietidæ," Preface, p. ix.

transverse sculpture obsolete. It is thus seen that the *asperum* sculpture is found in the intermediate and apical whorls. That is, the cancellate sculpture, or, more properly speaking, the transverse sculpture, has been gradually forced back toward the earlier stages of growth, and is wholly lost in the adult stages of *B. quadrifilatum.*

The next species in the series is *B. filosum.* This species is found very sparingly in the lower San Pedro, and although not common in the upper San Pedro, is noticeably more abundant in this later horizon than in the one preceding. Its separation from *B. quadrifilatum* no doubt began early in the Pleistocene, but this type did not reach a full development until the time of the upper San Pedro. The sculpture of this species consists primarily of spiral ridges or raised lines. This to the naked eye seems to be the only sculpture in typical specimens, but with the aid of a microscope the apical whorls are seen to have quite prominent transverse ridges, giving them (with the spiral ridges) a cancellate or *asperum* sculpture. Thus we see that the sculpture developed in the adult *B. asperum* is forced out of the adult stages and back into the adolescent stages, while in *B. filosum* we have the same sculpture occurring only in the apical whorls, or larval stage. As the larval period is the earliest in which we may study the shell of the gastropod, we may reasonably suppose that in the next marked period of development this cancellate sculpture would be completely lost, leaving only the typical *B. filosum*, or spiral sculpture, to ornament the whole shell from its larval to its adult stage, unless new characteristics of sculpture were developed in the meantime.

The spiral sculpture has been the persistent character in this series, while the transverse has been nearly lost by being forced back further and further toward the embryonic stage in succeeding individuals, until we have it remaining only in the very earliest whorls of *B. filosum.*

It is true that all three of these species are living at the present day, and that the transverse sculpture has persisted in certain individuals up to the present time, but they are sufficiently differentiated to call by different specific names. It is evident that in the case of the *Bittiums* under discussion, the development of what we call species has been brought about, not so much by the acquiring of certain specific characteristics, as by the gradual loss of a certain characteristic already possessed by the ancestral form.

TABLE SHOWING DEVELOPMENT OF SCULPTURE.

| | Larval stage, apical whorls. | Adolescent stage, intermediate whorls. | Adult stage, penultimate and body-whorl. |
|---|---|---|---|
| *B. filosum* (Upper San Pedro)..... | spiral and weak transverse. | spiral. | spiral. |
| *B. quadrifilatum* (Lower San Pedro).. | spiral and transverse. | spiral and weak transverse. | spiral. |
| *B. asperum* (Pliocene)..... | spiral and transverse. | spiral and transverse. | spiral and transverse. |

### 319. Bittium rugatum *Carpenter.*

PLATE IV, FIG. 11.

*Bittium rugatum* CPR., Ann. & Mag. Nat. Hist., 3rd Ser., Vol. XVII, 1866, p. 276.

Shell small, turreted; spire elevated; apex acute; whorls ten to eleven, flat; numerous transverse ridges, crossed by a varying number of nearly equally prominent spiral ridges, produce a nodose-cancellated sculpture; the spiral ridges increase in number on the anterior whorls; suture very deeply impressed, forming a sutural canal; body-whorl angulated, base ornamented with fine spiral and transverse lines; aperture subrectangular; outer lip thin, smooth; columella incrusted; canal short.

*Dimensions.*—Long. 13 mm.; lat. 5 mm.; body-whorl 6 mm.; aperture 3.5 mm.; defl. 23 degrees.

This species is quite variable in sculpture, owing to the varying number of spiral ridges on different individuals. The specimen described was identified by Dr. Dall.

Common in the lower San Pedro series at Deadman Island and San Pedro, and in upper San Pedro series at Deadman Island, Crawfish George's, Los Cerritos, and San Pedro. The specimen figured is from the upper San Pedro series at San Pedro, and is now in the collection of Delos Arnold.

*Living.*—Catalina Island to San Diego (Cooper).

*Pleistocene.*—Santa Barbara to San Diego (Cooper): San Pedro (Arnold).

### 320. Bittium williamsoni, sp. nov.

PLATE VI, FIG. 11.

Shell small, elongate, turreted; whorls seven, angular, flat and sloping above, straight below; upper surface of whorl minutely cancellate with fine spiral and transverse ridges; lower surface with two prominent spiral ridges and faint transverse ribs; suture deeply impressed, distinct; aperture circular; base smooth; basal angle rounded slightly.

*Dimensions.*—Long. 2.5 mm.; lat. 1 mm.

This is the smallest of the *Bittiums* found in the San Pedro deposits, and is distinguishable by its small size, prominently turbinated apex, and prominent cancellated sculpture. The specimen figured is the type, which was identified as a new species by Dr. Dall, and which is now in the United States National Museum.

Found in the upper San Pedro series of San Pedro. Also found in the Pleistocene at Spanish Bight, near San Diego.

*Living.*—(*Ubi?*) (Dall).

*Pleistocene.*—San Pedro (Arnold).

### Subgenus Styliferina *A. Adams.*

Diaphanous; conical turreted; whorls smooth, convex; apex mucronate; aperture subquadrate; inner lip straight.

*Bittium orthochila* A. Ads. is a characteristic species.

### 321. Bittium (Styliferina) tenuisculpta *Carpenter*.

PLATE VI, FIG. 14.

Shell small, conical, turreted, thin, diaphanous; apex sharp; whorls ten, rounded, nearly smooth, but showing faint spiral sculpture; suture deep, distinct; body-whorl evenly rounded below; aperture subrotund; outer lip thin; inner lip simple.

*Dimensions.*—Long. 5 mm.; lat. 2 mm.; body-whorl 2.5 mm.; aperture 7.5 mm.; defl. 20 degrees.

Specimens identified by Dr. Dall.

Rare in lower San Pedro series of San Pedro; one specimen found, which is figured, and is now in the collection of Delos Arnold.

*Living.*—West Coast (?).

*Pleistocene.*—San Pedro (Arnold).

## Genus **Diastoma** *Deshayes*.

Shell turreted; whorls with numerous transverse ribs, and with a few intermediate varices; inner margin of the aperture partially detached from the previous whorl; the aperture itself is strongly contracted posteriorly.

### 322. Diastoma, sp. indet.

Shell small, regularly conical, turreted; whorls seven, convex, ornamented with eleven slightly oblique transverse ridges, which are most prominent on the angle of the whorl and become obsolete at the sutures; suture deeply impressed; aperture broadly elliptical; outer lip thin; inner lip smooth; canal short.

*Dimensions.*—Long. 10.5 mm.; lat. 4.5 mm.; body-whorl 5.8 mm.; aperture, 4 mm.; defl. 28 degrees.

The above description was taken from a shell which Dr. Dall pronounced a young of the genus *Diastoma*.

Lower Pleistocene of San Pedro, only one specimen. A specimen of the same species (?) was found in the Pleistocene at the bath-house, Santa Barbara.

*Pleistocene.*—San Pedro; Santa Barbara (Arnold).

## Genus **Cerithidea** *Swainson*.

Shell turriculated, longitudinally ribbed; whorls numerous; summit of spire more or less decollated; aperture rounded, slightly slit anteriorly; outer lip expanded, thickened, broadly rounded below, and usually produced into a beak crossing the sinus to the left.

*Cerithidea decollatum* Linn. is a characteristic species.

### 323. Cerithidea californica *Haldemann*.

*Cerithium californicum* HALD., Fr. W. Univ. Moll., cover of No. 1, 1840.

*Cerithium* (*Potamis*) *sacratum* GLD., Proc. Bost. Soc. Nat. Hist., Vol. III, 1849, p. 118; Wilkes' Expl. Exped., Vol. XII, p. 114, Pl. X, fig. 116, 1852. TRYON, Man. Conch., Vol. IX, p. 162, Pl. XXXIII, figs. 69-72, 1887.

*Cerithidea sacrata* GLD., CPR., Proc. Zool. Soc., 1856, p. 226. KEEP, West Coast Shells, p. 71, fig. 56, 1892.

*Cerithidea californica* HALD., GABB, Pal. Cal., Vol. II, p. 79, 1869. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 233. DALL, Trans. Wagner Inst. Sci., Vol. III, Part 2, 1892, p. 277. WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 205.

Shell turreted; apex decollated; whorls nine or ten, slightly convex, ornamented with three or four spiral ridges and numerous transverse ridges, the two sets varying in prominence; suture impressed, distinct; aperture subquadrate; outer lip effuse, thickened, broadly rounded below, and slightly produced in a columellar beak; inner lip straight above this beak.

*Dimensions.*—Alt. 25 mm.; lat. 9.5 mm.; defl. 22 degrees.

This is the only representative of this genus, and is one of the commonest of the gastropods in the upper San Pedro formation.

Found in the Pliocene of Deadman Island, lower San Pedro series of Deadman Island and San Pedro, and upper San Pedro series of Crawfish George's, Los Cerritos, San Pedro, and Deadman Island. Found in the Pleistocene at Twenty-sixth Street and Pacific Beach, San Diego.

*Living.*—Baulinas Bay to San Diego; Mazatlan (Cooper).

*Pleistocene.*—San Pedro to San Diego (Cooper): San Pedro; San Diego (Arnold).

*Pliocene.*—San Fernando, Los Angeles County (Cooper): San Pedro (Arnold).

## Family LXX. CÆCIDÆ.

### Genus **Cæcum** *Fleming.*

Young shell spiral in one plane, afterwards an arcuated tube, truncated posteriorly by the loss of the spiral portion, and closed there by a convex septum or plug.

*Cœcum cornuoides* is a characteristic species.

### 324. **Cæcum californicum** *Dall.*

PLATE VIII, FIG. 6.

*Cæcum cooperi* CPR., Brit. Assn. Rept., 1863, p. 655; not of SMITH (*fide* DALL).

*Cæcum californicum* DALL, Proc. U. S. Nat. Mus., Vol. VIII, 1885, p. 541. TRYON, Man. Conch., Vol. VIII, p. 219, Pl. LXVI, fig. 65, 1886. KEEP, West Coast Shells, p. 73, 1892. DALL, Trans. Wagner Inst. Sci., Vol. III, Part 2, 1892, p. 299.

Shell small, tubular, curved, white, very slightly tapering; plug bent toward convex side; aperture circular, slightly contracted; surface ornamented by thirty to forty prominent, narrow, rounded rings.

*Dimensions.*—Long. (maximum) 3 mm.; lat. 0.9 mm.

Shell may be distinguished from *C. crebricinctum* by its small size and much more prominent, narrow, sharp rings.

Quite common in the upper San Pedro series of San Pedro and Crawfish George's, and in the lower San Pedro series of Deadman Island and San Pedro.

The specimen figured is from the lower San Pedro series at Deadman Island, and is now in the collection of Delos Arnold.

*Living.*—Santa Barbara Island to San Diego (Carpenter): Catalina Island, 20 fathoms (Arnold, 1901).

*Pleistocene.*—San Pedro (Arnold): San Diego (Stearns).

*Pliocene.*—San Quentin Bay, Lower California (Orcutt).

### 325. Cæcum crebricinctum *Carpenter.*

PLATE VIII, FIG. 10.

*Cæcum crebricinctum* CPR., Brit. Assn. Rept., 1863, p. 655; Proc. Cal. Acad. Sci., Vol. III, 1865, p. 215. TRYON, Man. Conch., Vol. VIII, p. 218, Pl. LXVII, fig. 71, 1886. KEEP, West Coast Shells, p. 73, 1892. DALL, Trans. Wagner Inst. Sci., Vol. III, Part 2, 1892, p. 300. WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 204.

Shell small, white, curved, tubular, thin; ornamented with very fine, close, annular ring sculpture; plug subangulate, bent toward convex side.

*Dimensions.*—Long. 5.5 mm.; lat. 1 mm.

Distinguishable from *C. californicum* by its larger size and less prominent rings. The specimen described was identified by Dr. Dall.

Found in the lower San Pedro series of Deadman Island and San Pedro, and in the upper San Pedro series of San Pedro and Crawfish George's. The specimen figured is from the lower San Pedro series at San Pedro, and is now in the collection of Delos Arnold.

*Living.*—Monterey to San Diego (Carpenter): San Pedro (Williamson): Catalina Island, 20 fathoms (Arnold, 1901).

*Pleistocene.*—San Pedro (Arnold): San Diego; Coronado Beach (Dall).

*Pliocene.*—San Quentin Bay, Lower California (Orcutt).

### 326. Cæcum magnum *Stearns.*

PLATE VIII, FIG. 16.

*Cæcum magnum* STEARNS, TRYON, Man Conch., Vol. VIII, p. 219, Pls. LXVII, LXXXIII, 1886.

Shell small, tubular, curved, tapering; surface sculptured with numerous fine rings; aperture circular; plug sharp.

*Dimensions.*—Long. 5 mm.; latitude, base, 0.9 mm.; apex 0.3 mm.

This species resembles *C. crebricinctum*, but differs from that species in being more curved and in tapering much more rapidly from the anterior to the posterior extremity. Specimen identified by Dr. Dall. Tryon's figure may be of *C. crebricinctum*. One specimen from the lower San Pedro series of Deadman Island, which is figured, and is now in the collection of Delos Arnold.

*Living.*—?

*Pleistocene.*—San Pedro (Arnold).

## Family LXXI. VERMETIDÆ.

### Genus **Serpulorbis** *Sassi.*

Shell tubular, irregularly twisted, adherent; aperture rounded; columella not plicate.

*Serpulorbis arenaria* Quoy. is a characteristic species.

#### 327. **Serpulorbis squamigerus** *Carpenter.*

*Aletes squamigerus* CPR., Proc. Zool. Soc., 1856, p. 226.

*Serpulorbis squamigerus* CPR., Brit. Assn. Rept., 1863, p. 654. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 264. KEEP, West Coast Shells, p. 74, 1892. WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 204.

*Vermetus squamigerus* CPR., TRYON, Man. Conch., Vol. VIII, p. 181, Pl. LIV, figs. 73, 74, 1886.

Shell tubular, irregularly twisted, adherent; surface may be transversely or longitudinally ornamented, generally, however, only showing circular incremental lines; aperture circular.

*Dimensions.*—Diameter from 2 mm. to 15 mm.

In some cases found attached to rocks in conglomerate, in others found in irregular aggregates or individual sections.

Common in the upper San Pedro series of San Pedro and vicinity; rare in the lower San Pedro series of Deadman Island and San Pedro. Found in the Pleistocene at Pacific Beach, San Diego.

*Living.*—Monterey to San Diego (Cooper).

*Pleistocene.*—Santa Barbara to San Diego (Cooper): San Pedro; San Diego (Arnold).

### Subgenus **Vermicularia** *Lamarck.*

#### 328. **Serpulorbis (Vermicularia)**, sp. indet.

One small nepionic shell of a species of this genus was found in the lower San Pedro series of San Pedro. Specimen identified by Dr. Dall.

*Pleistocene.*—San Pedro (Arnold).

### Genus **Spiroglyphus** *Daudin.*

Animal forming a groove on the surface of shells or stones, covering it over with shelly matter, and forming a tubular case.

*Spiroglyphus spirorbis* Dillw. is a characteristic species.

#### 329. **Spiroglyphus lituella** *Morch.*

*Siphonium (Dendropoma) lituella* MORCH., Proc. Zool. Soc., 1861, p. 154.

*Spiroglyphus lituella* MORCH., CPR., Brit. Assn. Rept., 1863, p. 654. KEEP, West Coast Shells, p. 73, 1892. WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 204.

Shell small, irregularly and sometimes openly spiral, rather compressed; color dingy white; surface sculptured by incremental lirulæ and arcuate striæ, which are approximately regular; aperture circular.

*Dimensions.*—Diameter of coil 1.5 mm.

This little animal forms a groove on the surface of shells or stones, and covers it over with shelly matter, forming a tubular case.

Common on stones and shells of upper San Pedro series at San Pedro, Deadman Island, Crawfish George's, and Los Cerritos.

*Living.*—California coast (Carpenter).

*Pleistocene.*—San Pedro (Arnold).

## Family LXXII. TURRITELLIDÆ.

### Genus **Turritella** *Lamarck.*

Shell elongated; many whorled; whorls rounded, with revolving striæ; aperture rounded.

*Turritella terebra* Linn. is a characteristic species.

### 330. Turritella cooperi *Carpenter.*

*Turritella cooperi* CPR., Brit. Assn. Rept., 1863, p. 655; Proc. Cal. Acad. Sci., Vol. III, 1864, p. 216. GABB, Pal. Cal., Vol. II, p. 80, 1869. TRYON, Man. Conch., Vol. VIII, p. 20, Pl. LXI, 1886. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 269. KEEP, West Coast Shells, p. 73, fig. 58, 1892. DALL, Trans. Wagner Inst. Sci., Vol. III, Part 2, 1892, p. 318. WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 205.

This species is distinguishable from *T. jewettii* by its deeply impressed and distinct suture, faint spiral ridges (lacking entirely in some specimens), circular aperture, and sharper spire, the deflection in this species being only 10 degrees. Resembles Atlantic form, *T. apicalis.*

Rather common in the Pliocene and Pleistocene of San Pedro and vicinity. Found in the Pliocene at Pacific Beach and Russ School, San Diego; and in the Pleistocene at Pacific Beach, San Diego; and at Barlow's ranch and the irrigating ditch, Ventura.

*Living.*—Santa Barbara to San Diego (Cooper).

*Pleistocene.*—Santa Barbara to San Diego (Cooper): San Pedro; San Diego; Ventura (Arnold).

*Pliocene.*—San Diego well (Dall): San Pedro; San Diego (Arnold): San Quentin Bay, Lower California (Orcutt).

### 331. Turritella jewettii *Carpenter.*

PLATE IV, FIG. 13.

*Turritella jewettii* CPR., Brit. Assn. Rept., 1863, p. 655; Ann. & Mag. Nat. Hist., 3rd Ser., Vol. XVII, 1866, p. 276. GABB, Pal. Cal., Vol. II, p. 80, 1869. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 269.

? *Turritella sanguinea* REEVE, COOPER (WILLIAMSON), Bull. No. 4, Cal. St. Min. Bureau, 1894, Part 3, p. 32.

Shell turreted, with slender, tapering spire; number of whorls variable; whorls flat, with two distinct spiral ridges on anterior portion and three or four less distinct ridges posteriorly; incremental lines distinct and concave anteriorly; suture thread-like and rather indistinct, not usually impressed; aperture angular.

*Dimensions.*—Defl. 16 degrees.

The spiral sculpture in this species is quite variable, the prominence of the various ridges not being constant; the suture is also somewhat impressed in some specimens. A more solid shell than *T. cooperi*, being less slender, having more prominent spiral sculpture, a more angular aperture and a less distinct suture than the latter species. The shell listed by Mrs. Williamson as *T. sanguinea* from the San Pedro Pleistocene is probably this species, as Carpenter in his original description (the type being a Pleistocene fossil from Santa Barbara) says that *T. jewettii* is near *T. sanguinea*.

Common in the Pliocene, rarer in the lower San Pedro series, and still rarer in the upper San Pedro series of San Pedro and vicinity. The specimen figured is from the Pliocene of Deadman Island, and is now in the collection of Delos Arnold.

*Pleistocene.*—Santa Barbara to San Diego (Cooper): San Pedro (Arnold).

*Pliocene.*—San Diego well (Dall): San Pedro (Arnold).

## Family LXXIII. LITTORINIDÆ.

### Genus **Littorina** *Ferussac.*

Shell turbinated, thick, pointed, few-whorled; aperture rounded; outer lip acute; columella rather flattened, imperforate.

*Littorina litorea* Linn. is a characteristic species.

### 332. **Littorina planaxis** (*Nuttall*) *Philippi.*

*Littorina planaxis* NUTT., PHILIPPI, *teste* CPR., Proc. Zool. Soc., 1856, p. 266. CPR., Brit. Assn. Rept., 1863, p. 655. GABB, Pal. Cal., Vol. II, p. 80, 1869. TRYON, Man. Conch., Vol. IX, p. 248, Pl. XLIII, figs. 55, 56; Pl. XLIV, fig. 57, 1887. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 246. KEEP, West Coast Shells, p. 68, fig. 53, 1892. =*L. patula* GLD. (*fide* DALL, Trans. Wagner Inst. Sci., Vol. III, Part 2, 1892, p. 321). WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 205.

Shell small, broadly conical; spire not much elevated; whorls three, convex, the last being ventricose; surface roughened by lines of growth; aperture ovate; outer lip thin; inner lip and columella flattened and effuse.

*Dimensions.*—Alt. 8 mm.; lat. 6.2 mm.; aperture 5 mm. x 3.5 mm.; defl. 70 degrees.

Distinguishable from *L. scutulata* by lack of coloration, rough surface, very effuse inner lip, greater deflection, and fewer whorls. Specimens identified by Dr. Dall.

One specimen each, from the upper San Pedro series of San Pedro, and

lower San Pedro series of Deadman Island; found also in the lower San Pedro series at San Pedro; and in the Pliocene of Deadman Island.

*Living.*—Sitka; San Diego (Cooper).

*Pleistocene.*—San Nicolas Island; San Diego (Cooper): San Pedro (Arnold).

### 333. Littorina scutulata *Gould.*

*Littorina scutulata* GLD., Proc. Bost. Soc. Nat. Hist., Vol. III, 1849, p. 83; Wilkes' Expl. Exped., Vol. XII, p. 200, fig. 241, 1852. CPR., Brit. Assn. Rept., 1863, p. 656. TRYON, Man. Conch., Vol. IX, p. 250, Pl. XLV, figs. 98–103, 1887. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 246. KEEP, West Coast Shells, p. 68, fig. 52, 1892. WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 205.

*Littorina plena* GLD., Proc. Bost. Soc. Nat. Hist., Vol. III, 1849, p. 84; Wilkes' Expl. Exped., Vol. XII, p. 201, fig. 236, 1852.

Shell small, conical; spire elevated, subacute; whorls four, very slightly convex, the last one ventricose and slightly angulated; sculpture consists of numerous nearly obsolete, spiral striæ, and fine, oblique, incremental lines; aperture ovate; outer lip thin, lower part effuse; inner lip incrusted, effuse; color reddish brown.

*Dimensions.*—Alt. 10 mm.; lat. 6 mm.; aperture 5 mm. x 3 mm.; defl. 48 degrees.

All the specimens from the Pleistocene that have been examined show a characteristic reddish brown color. Several specimens identified by Dr. Dall; among them two which were marked "variety," but which have been included in this species for lack of constant varietal differences..

Found in the lower San Pedro series at Deadman Island and San Pedro; and in the upper San Pedro series at Los Cerritos, Crawfish George's, San Pedro, Long Beach, and Deadman Island. Found in the Pleistocene at Barlow's ranch, Ventura; and at Pacific Beach and Spanish Bight, San Diego.

*Living.*—Monterey to San Diego (Cooper).

*Pleistocene.*—San Pedro to San Diego (Cooper): San Pedro; Ventura; San Diego (Arnold).

## Genus **Lacuna** *Turton.*

Shell turbinated, thin; aperture semilunar; columella flattened, with an umbilical fissure.

*Lacuna pallidula* Da Costa is a characteristic species.

### 334. Lacuna compacta *Carpenter.*

*Lacuna ?* var. *compacta* CPR., Brit. Assn. Rept., 1863, p. 656.

*Lacuna* (*? solidula*, var.) *compacta* CPR., Ann. & Mag. Nat. Hist., 3rd Ser., Vol. XIV, 1864, p. 429. TRYON, Man. Conch., Vol. IX, p. 266, Pl. L, fig. 71, 1887.

Shell small, thin, compact; spire elevated, subacute; whorls four, slightly convex; body-whorl prominently angulated at base; suture impressed, distinct; aperture ovate; outer lip not effuse, thin; inner lip slightly effuse; chink very small, almost obsolete; surface faintly marked with very fine incremental lines.

*Dimensions.*—Long. 6 mm.; lat. 4 mm.; aperture 3 mm. x 2 mm.; defl. 60 degrees.

Distinguishable by its compactness, angulated body-whorl, small chink and angle of deflection. The specimen described was identified by Dr. Dall as probably being of this species.

Some specimens of *L. compacta* in the State Museum collection at Berkeley are labeled *L. solidula*.

Rare in lower San Pedro series at Deadman Island; and in the upper San Pedro series at Los Cerritos and San Pedro. Found in the Pleistocene at Barlow's ranch, Ventura; at bath-house, Santa Barbara; and at Spanish Bight, San Diego.

*Living.*—Vancouver district (Carpenter).

*Pleistocene.*—San Pedro; Ventura; Santa Barbara; San Diego (Arnold).

### 335. Lacuna porrecta *Carpenter.*

*Lacuna porrecta* CPR., Brit. Assn. Rept., 1863, p. 656; Ann. & Mag. Nat. Hist., 3rd Ser., Vol. XIV, 1864, p. 429. TRYON, Man. Conch., Vol. IX, p. 265, Pl. L, figs. 55, 56, 57, 1887. KEEP, West Coast Shells, p. 66, 1892.

Shell small, white; spire not much elevated; whorls three, convex; body-whorl very slightly angulated; suture distinct; aperture ovate; lip effuse; umbilical chink large.

*Dimensions.*—Long. 6 mm.; lat. 5 mm.; body-whorl 5.7 mm.; aperture 4.5 mm.; defl. 74 degrees.

Distinguishable by large umbilical chink, depressed spire, large angle at apex, and effuse outer lip.

Three specimens of this species found in the lower San Pedro series at Deadman Island; also found in same horizon at San Pedro; and in the upper San Pedro series at Deadman Island, San Pedro, Los Cerritos, and Crawfish George's.

*Living.*—Vancouver district (Carpenter).

*Pleistocene.*—San Pedro (Arnold).

### 336. Lacuna solidula (*Lovén*) *Carpenter.*

PLATE VIII, FIG. 11.

*Lacuna solidula* LOVÉN, Index Moll. Scandin., p. 23 (*teste* CPR., Brit. Assn. Rept., 1863, p. 656). GABB, Pal. Cal., Vol. II, p. 80, 1869. TRYON, Man. Conch., Vol. IX, p. 266, Pl. L, fig. 69, 1887. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 244. KEEP, West Coast Shells, p. 66, 1892. DALL, Trans. Wagner Inst. Sci., Vol. III, Part 2, 1892, p. 321. WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 205.
*Lacuna carinata* GLD., Proc. Bost. Soc. Nat. Hist., 1848, p. 75.
*Littorina pedroana* CON., Pac. R. R. Rept., Vol. V, p. 327, Pl. VI, fig. 50, 1856.
*Modelia striata* GABB, Proc. Phil. Acad. Nat. Sci., 1861, p. 368.

Shell small, turreted, thin; spire elevated, subacute; whorls four, rounded, ornamented with fine oblique incremental lines; suture deeply impressed, distinct; aperture large, ovate; outer lip thin; inner lip sharp, effuse, incrusted; small umbilical chink.

*Dimensions.*—Long. 10 mm.; lat. 6.2 mm.; body-whorl 7.5 mm.; aperture 5.5 mm.; defl. 44 degrees.

Distinguishable from other members of the genus found in this formation by its elevated spire, deeply impressed suture, and small deflection. The specimen described was identified by Dr. Dall.

Rare in lower San Pedro series at Deadman Island and upper San Pedro series at San Pedro. Found also in the Pleistocene at Pacific Beach, San Diego. The specimen figured is somewhat decorticated, came from the upper San Pedro series at San Pedro, and is now in the collection of Delos Arnold.

*Living.*—Alaska to San Diego (Cooper).

*Pleistocene.*—Santa Barbara to San Diego (Cooper): San Pedro; San Diego (Arnold).

## Family LXXIV. FOSSARIDÆ.

### Genus **Fossarus** *Philippi.*

Shell perforated, sculptured; inner lip thin; aperture semilunate.

*Fossarus costatus* Brocchi is a characteristic species.

### Subgenus **Isapis** *H. & A. Adams.*

Shell umbilicated; spire elevated; cancellated, or with revolving ribs; columella with a small median tooth.

*Isapis anomala* C. B. Adams is a characteristic species.

#### 337. **Fossarus (Isapis) fenestrata** *Carpenter.*

*Isapis fenestrata* CPR., Brit. Assn. Rept., 1863, p. 656; Ann. & Mag. Nat. Hist., 3rd Ser., Vol. XV, 1865, p. 28. KEEP, West Coast Shells, p. 65, 1892. WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 206.

Shell small, turreted; spire elevated, subacute; whorls four, slightly convex, ornamented with prominent, squarish, raised, spiral ridges, with numerous fine, oblique lirulæ in the interspaces; three spiral ridges on penultimate whorl, twelve to thirteen on body-whorl; suture deeply impressed, distinct; aperture ovate; outer lip thin, slightly effuse; inner lip flattened, effuse; umbilical chink small.

*Dimensions.*—Long. 8 mm.; lat. 7 mm.; body-whorl 7 mm.; aperture, 5 mm.; defl. 65 degrees.

Found in the lower San Pedro series of Deadman Island and San Pedro, and in the upper San Pedro series at Crawfish George's, San Pedro, and Deadman Island.

*Living.*—Vancouver to San Diego (Carpenter).

*Pleistocene.*—San Pedro (Arnold).

## Family LXXV. RISSOIDÆ.

### Genus **Rissoa** *Fréminville.*

Shell minute, white or horny; conical pointed, many-whorled; smooth, ribbed or cancellated; aperture rounded; peristome entire, continuous; outer lip slightly expanded, thickened.

*Rissoa costulata* Risso is a characteristic species.

### 338. Rissoa acutelirata *Carpenter.*

PLATE IV, FIG. 12.

*Rissoa acutelirata* CPR., Brit. Assn. Rept., 1863, p. 656.

Shell minute, conical, pointed, rather thick; whorls five, convex, with fifteen sharp, distant, spiral riblets, traveling over eighteen sharp distant ribs, which are obsolete on base of body-whorl; aperture ovate; peristome entire, continuous.

*Dimensions.*—Long. 1.5 mm.

This minute little shell is seen under the microscope to have a very cancellated sculpture. Specimens identified by Dr. Dall.

Rare in upper San Pedro series of San Pedro. Two specimens. Found also in the Pleistocene at the old irrigating ditch, Ventura. The specimen figured is from the upper San Pedro series at San Pedro, and is now in the collection of Delos Arnold.

*Living.*—San Diego (Carpenter).

*Pleistocene.*—San Pedro; Ventura (Arnold).

## Subfamily *HYDROBIINÆ.*

### Genus **Paludestrina** *d'Orbigny.*

Shell conical, more or less elongated; smooth, imperforate or nearly so; apex acute; aperture ovate; peritreme continuous; outer lip acute; inner lip not thickened.

*Paludestrina piscium* d'Orbigny is a characteristic species.

### 339. Paludestrina curta, sp. nov.

PLATE VIII, FIG. 2.

Shell small, conical, very thin; spire elevated; apex rounded; whorls four, very convex, smooth, except for obsolete transverse sculpture; suture deeply impressed, distinct; aperture oval; peritreme continuous, thin; umbilicus subperforate.

*Dimensions.*—Long. 4 mm.; lat. 2.2 mm.; body-whorl 2.6 mm.; aperture 1.5 mm.; defl. 38 degrees.

Distinguishable from *P. stokesi* by much broader shell, fewer whorls, and more perforate umbilicus. Pronounced a new species by Dr. Dall.

Rare in lower and upper San Pedro series of San Pedro. The specimen figured is the type, which is from the lower San Pedro series at San Pedro, and is now in the United States National Museum.

*Pleistocene.*—San Pedro (Arnold).

### 340. Paludestrina stokesi, sp. nov.

PLATE VIII, FIG. 3.

Shell small, conical, thin; spire elevated; apex acute; whorls six, very convex; surface with faint, nearly obsolete, rounded, transverse ridges; suture deeply impressed, distinct; body-whorl

evenly ventricose; aperture oval; peritreme continuous; outer lip acute; inner lip not thickened; umbilicus nearly obsolete.

*Dimensions.*—Long. 4.8 mm.; lat. 2 mm.; body-whorl 2.5 mm.; aperture 1 mm.; defl. 22 degrees.

This little fresh-water gastropod is distinguishable by its small size, thin shell, very convex whorls and continuous peritreme. Specimens pronounced a new species by Dr. Dall. Named in honor of Mr. Frank Stokes of Pasadena, California.

Rare in upper and lower San Pedro series of San Pedro. The specimen figured is the type, which is from the lower San Pedro series at San Pedro, and is now in the United States National Museum.

*Pleistocene.*—San Pedro (Arnold).

## Family LXXVI. CALYPTRÆIDÆ.

### Genus **Crucibulum** *Schumacher.*

Shell conical, more or less regular, with subcentral, subposterior, sharp apex; aperture basal, with a central, internal, cup-shaped lamina, which is entire, and attached along a line on one side to the inner wall of the shell.

#### Section *Crucibulum, s. s.*

Distinguished from *Dispotæa* by having in the adult the whole margin of the internal cup free from the shell, and the cup as a whole merely attached by a narrow strip of adhesion.

*Crucibulum rudis* Brod. is a characteristic species.

### 341. **Crucibulum spinosum** *Sowerby.*

*Calyptræa spinosa* SBY., Gen. of Shells, Pl. XXIII, figs. 4, 7, 1824.

*Crucibulum spinosum* SBY., REEVE, Icon. Conch., Sp. 10. CONRAD, Pac. R. R. Rept., Vol. V, p. 327, Pl. V, fig. 46, 1856. CPR., Brit. Assn. Rept., 1856, p. 323, Pl. IX, figs. 3*a*, 3*b*; *id.*, 1863, p. 654. GABB, Pal. Cal., Vol. II, p. 81, 1869; Geol. San Domingo, p. 241, 1873. TRYON, Man. Conch., Vol. VIII, p. 118, Pl. XXXII, fig. 38, 1886. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 237. KEEP, West Coast Shells, p. 77, fig. 62, 1892. WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 203.

*Crucibulum auricula* var. *spinosum* SBY., =*Dispotæa dumosa* CON. (young shell), =*Crucibulum dumosum* TUOMEY & HOLMES (young shell), (*fide* DALL, Trans. Wagner Inst. Sci., Vol. III, Part 3, 1892, p. 350.)

Shell conical, elevated; apex rather acute, slightly curved, smooth, subcentral; surface ornamented with numerous rounded, radiating ridges, and sometimes with concentric rows of spires; concentric lines of growth visible; a cup-shaped lamina is attached along a line on one side of the interior of the shell; inner surface smooth; rim thin; aperture nearly circular.

*Dimensions.*—Diam. 21 mm.; alt. 13.5 mm.

The only member of this genus found in the San Pedro series of this locality. Dr. Dall says that the recent specimens from California agree in the minutest particular with the Caloosahatchie fossils. This is probably a case of a survival of an old form.

Common in the lower San Pedro series of Deadman Island, and in upper San Pedro series of Deadman Island, San Pedro, Los Cerritos, Long Beach, and Crawfish George's. Found in the Pleistocene at Twenty-sixth Street and Pacific Beach, San Diego.

*Living.*—Monterey to San Diego (Carpenter): south to Peru (Cooper).

*Pleistocene.*—Santa Barbara (Cooper): San Pedro; San Diego (Arnold).

*Pliocene.*—San Diego well (Dall): Caloosahatchie beds and Alligator Creek, Florida (Dall and Willcox).

*Miocene.*—(Newer) North and South Carolina (Conrad and Holmes): (older) San Domingo (Gabb).

### Genus **Galerus** *Humphrey.*

Shell depressed, subconical, spiral; summit subcentral; aperture very large, basal, with a subspiral broad lamina adhering to the left margin.

*Galerus chinensis* Linn. is a characteristic species.

### 342. **Galerus mammillaris** *Broderip.*

*Galerus mammillaris* BROD., Trans. Zool. Soc., 1835, Pl. XXIII, fig. 5. CPR., Brit. Assn. Rept., 1856, p. 323. =*Calyptrea fastigiata* GLD., = (?) *Galerus contortus* CPR. (*fide* DALL, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 203).

*Calyptrea mammillaris* BROD., TRYON, Man. Conch., Vol. VIII, p. 120, Pl. XXXIV, figs. 64–75, 78–81, 1886.

Shell depressed, subconical; whorls flattened, three; apex central, blunt; aperture subcircular, large; a broad lamina begins at apex on inner surface and makes a whole turn to the left, reaching nearly to margin; lower part of body-whorl corrugated; surface marked by irregular spiral striæ.

*Dimensions.*—Long. 32 mm.; lat. 30 mm.; alt. 7 mm.

The specimen described was identified by Dr. Dall.

Rare in lower San Pedro series of Deadman Island and San Pedro; and in the upper San Pedro series at Crawfish George's and San Pedro.

*Living.*—Puget Sound to Monterey (Cooper): Santa Barbara to Central America (Carpenter): San Pedro (Williamson).

*Pleistocene.*—San Pedro (Arnold).

*Pliocene.*—San Diego well (Dall).

### Genus **Crepidula** *Lamarck.*

Shell oval, limpet-like, with a posterior, generally lateral spiral apex; interior with a shelly lamina covering its posterior half.

*Crepidula peruviana* Lam. is a characteristic species.

### 343. Crepidula aculeata *Gmelin.*

*Patella aculeata* GMEL., Syst. Nat., p. 3693, 1788.

*Crepidula aculeata* GMEL., =*Calyptræa echinus* BROD., =*Calyptræa hystrix* BROD., =*Crepidula californica* NUTT. (*fide* CPR., Brit. Assn. Rept., 1856, p. 323, Pl. VIII, figs. 3*a*, 3*j*). CPR., Brit. Assn. Rept., 1863, p. 654. TRYON, Man. Conch., Vol. VIII, p. 129, Pl. XXXIX, figs. 61-65, 1886. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 236. DALL, Bull. U. S. Nat. Mus., No. 37, 1889, p. 152. KEEP, West Coast Shells, p. 76, 1892. DALL, Trans. Wagner Inst. Sci., Vol. III, Part 2, 1892, p. 357. WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 203.

Shell small, deep, thin; apex near anterior margin curved to left, smooth; surface sculptured with numerous prominent rounded, discontinuous, irregular ridges from near apex to margin; margin thin, crenulated; aperture subquadrate; deck oblique, thin, cupped, lower on right side than on left; inner surface smooth.

*Dimensions.*—Long. 11 mm.; lat. 9 mm.; alt. 6 mm.

The specimen described was identified by Dr. Dall. The occurrence of this species on both sides of the American continent is probably due to the survival of an old form which has changed little since the two regions were closely connected by water.

Rare in the lower San Pedro series of San Pedro and Deadman Island.

*Living.*—Monterey, south; Asia; Atlantic (Cooper).

*Pleistocene.*—San Pedro to San Diego (Cooper): San Pedro (Arnold).

*Pliocene.*—San Fernando (Cooper): De Leon Springs, Shell Creek, and Alligator Creek, Florida (Dall and Willcox).

### 344. Crepidula adunca *Sowerby.*

*Crepidula adunca* SBY., Tank. Cat., Appen., p. 7, 1825. CPR., Brit. Assn. Rept., 1863, p. 654. GABB, Pal. Cal., Vol. II, p. 82, 1869. TRYON, Man. Conch., Vol. VIII, p. 129, Pl. XXXVIII, figs. 51–55; Pl. XXXVII, figs. 39, 40; Pl. XXXIX, fig. 60, 1886. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 236. KEEP, West Coast Shells, p. 75, fig. 60, 1892. DALL, Trans. Wagner Inst. Sci., Vol. III, Part 2, 1892, pp. 355, 358. WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 203.

*Crepidula rostriformis* GLD., Proc. Bost. Soc. Nat. Hist., Vol. II, 1846, p. 160; Wilkes' Expl. Exped., Vol. XII, p. 375, fig. 482, 1852.

*Crypta adunca* SBY., H. & A. ADAMS, Gen. Rec. Moll., Vol. I, p. 369, 1853.

Shell nearly circular at base, elevated and curved backwards to apex; apex elevated, sharp, hooked, and removed from margin; surface marked with fine lamellar lines of growth; aperture nearly circular; margin thin; deck short, thin in middle, thicker towards sides, with anterior edge deeply curved; cavity penetrates beak from deck; deck set deep in shell.

*Dimensions.*—Long. 19 mm.; lat. 12.5 mm.; alt. 10.5 mm.; aperture 15 mm. x 12.5 mm.

This shell is easily distinguishable by its elevated apex and short, curved-edged deck. Dr. Dall identified the shell described. This is the West Coast form of the Atlantic *C. convexa* Sby.

Rather rare in the lower San Pedro series of Deadman Island and San Pedro; and in the upper San Pedro series of Los Cerritos, Crawfish George's, San Pedro, and

Deadman Island. Found in the Pleistocene at the bath-house, Santa Barbara; at Barlow's ranch, Ventura; and at Spanish Bight, San Diego.

*Living.*—Straits of Fuca to Santa Barbara; Mexico (Cooper).

*Pleistocene.*—Santa Barbara; San Diego (Cooper): San Pedro; Santa Barbara; Ventura; San Diego (Arnold).

### 345. Crepidula dorsata *Broderip.*

*Crepidula dorsata* BROD., Proc. Zool. Soc., 1834, p. 38. CPR., Brit. Assn. Rept., 1863, p. 654. GABB, Pal. Cal., Vol. II, p. 82, 1869. TRYON, Man. Conch., Vol. VIII, p. 127, Pl. XXXVII, figs. 26–30; Pl. XXXVIII, fig. 41, 1886. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 236. KEEP, West Coast Shells, p. 76, 1892. DALL, Trans. Wagner Inst. Sci., Vol. III, Part IV, 1892, p. 358.

*Crypta dorsata* BROD., H. & A. ADAMS, Gen. Rec. Moll., Vol. I, p. 369, 1853.

Shell small, much depressed; apex curved to one side and upward, smooth on tip; surface sculptured with rough, rounded, radiating ridges, expanding and also increasing in number by intercallation toward the margin; aperture round; margin crenulated and thickened; deck partly detached, thin, oblique, with pit at apex.

*Dimensions.*—Diam. 10 mm.; alt. 3 mm.

Rare in the lower San Pedro series of Deadman Island; and upper San Pedro series of Crawfish George's and Los Cerritos.

*Living.*—Straits of Fuca to Mazatlan; Peru, South America (Cooper).

*Pleistocene.*—Santa Barbara (Cooper): San Pedro (Arnold).

*Pliocene.*—San Fernando (Cooper).

### 346. Crepidula grandis *Middendorff.*

*Crepidula grandis* MIDD., Mal. Ross., Part II, p. 101, Pl. XI, figs. 8, 9, 10, 1849. CPR., Brit. Assn. Rept., 1863, p. 584. GABB, Pal. Cal., Vol. II, p. 81, 1869. TRYON, Man. Conch., Vol. VIII, p. 127, Pl. XXXVII, fig. 33, 1886. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 237. DALL, Trans. Wagner Inst. Sci., Vol. III, Part II, 1892, p. 358.

Shell heavy, elevated obliquely from an oval base; sides flattened; apex narrowed, curving nearly to side margin; surface sculptured by numerous fine lamellar lines of growth; deck long, thick (much thicker on side opposite from apex) and showing lines of growth on inner side, occupies over half of aperture, joins shell near margin.

*Dimensions.*—Long. 80 mm.; lat. 50 mm.; alt. 45 mm.; aperture 60 mm.

The rim, especially near the posterior end, shows the lamellar structure of the shells. These shells have a very pronounced habit of growing one upon another until the group sometimes numbers six or eight individuals. This species is easily recognized by its size and thickness.

Dr. Dall unites *C. prærupta* Con. and *C. princeps* Con., but separates this species from *C. grandis* Midd. It has been the writer's privilege to examine quite a series of *C. prærupta* Con. from the Astoria Miocene of Blakeley, Washington, and

it is his opinion, also, that this species is distinct from *C. grandis*. Two specimens in the upper San Pedro series of Deadman Island. Found also in the Pliocene at Pacific Beach, San Diego.

*Living.*—Kamtschatka; Hakodate, Japan; Okhotsk (Carpenter).

*Pleistocene.*—Santa Barbara (Cooper): San Pedro (Arnold).

*Pliocene.*—Santa Rosa; Kirker's Pass; Santa Barbara; San Fernando; San Diego well (Cooper): Alpine Creek, San Mateo County; Stanford University; San Diego (Arnold).

*Miocene*—Tomales, Marin County; Walnut Creek, Contra Costa County; Foxin's and Santa Rosa Island, Santa Barbara County (Cooper).

### 347. Crepidula navicelloides *Nuttall.*

*Crepidula navicelloides* NUTT., Jay's Cat., No. 3035, 1835. CPR., Brit. Assn. Rept., 1863, p. 654. GABB, Pal. Cal., Vol. II, p. 82, 1869. TRYON, Man. Conch., Vol. VIII, p. 126, 1886. COOPER, 7th Ann. Rept., Cal. St. Min., 1888, p. 237. KEEP, West Coast Shells, p. 76. fig. 61, 1892. WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 203.

*Crepidula nummaria* GLD., Proc. Bost. Soc. Nat. Hist., Vol. II, 1846, p. 60; Wilkes' Expl. Exped., Vol. XII, p. 377, fig. 480, 1852.

*Crepidula explanata* GLD., Mex. and Cal. Shells, p. 4, Pl. XIV, fig. 7, 1853; Proc. Zool. Soc., 1856, p. 205.

This shell varies greatly in shape, due to the surface on which it grows. Specimens showing an easy gradation from the circular, flat variety, *C. nummaria*, through the typical, oblong, flat, *C. navicelloides*, to the elongated, curved variety, *C. explanata*, have been found in the upper San Pedro series of San Pedro. This species may be distinguished from the other members of this genus by its flat or dorsally concave appearance, and by the way in which the deck is raised in the center to allow body space between it and the inner surface of the shell. Representatives of the above forms were identified by Dr. Dall as this species.

Rare in the lower San Pedro series of Deadman Island; and in the upper San Pedro series of Crawfish George's, Los Cerritos, San Pedro, and Deadman Island. Found also in the Pleistocene at the bath-house, Santa Barbara.

*Living.*—Alaska to San Diego (Cooper).

*Pleistocene.*—Santa Barbara (Cooper): San Pedro; Santa Barbara (Arnold).

*Pliocene.*—San Diego well (Dall).

### 348. Crepidula onyx *Sowerby.*

*Crepidula onyx* SBY., Genera of Shells, No. 23, fig. 2, 1824. CPR., Proc. Zool. Soc., 1856, p. 225; Brit. Assn. Rept., 1856, p. 323. TRYON, Man. Conch., Vol. VIII, Pl. XXXVII, fig. 37; Pl. XXXVIII, figs. 43–50; Pl. XXXIX, fig. 59, 1886.

Shell ovate, generally irregular, low arched, strong; apex small, marginal, sharp and turned to one side; surface marked by concentric lamellar lines of growth; aperture irregularly ovate; rim

thin; interior reddish brown (shows in all Pleistocene specimens examined), except for border equal in width to the space between the deck and the rim, which is light colored; deck thin, with nearly straight edge; slight depression where deck joins shell on right side; deck curves upward at margin where it joins shell, making the line of contact indistinct in most specimens, the deck merging into the shell.

*Dimensions.*—Long. 32 mm.; lat. 25 mm.; alt. 10 mm.

This shell may be distinguished from *C. rugosa* by its larger size, depressed form, interior coloration, and by the indistinctness of the line of contact between the deck and the shell. The deck of *C. onyx* is also joined to the shell nearer the rim than is the deck of either *C. rugosa* or *C. adunca*.

This specimen was identified by Dr. Dall.

Rare in the lower San Pedro series of Deadman Island and San Pedro; and in upper San Pedro series of Deadman Island, Los Cerritos, and San Pedro. Found also in the Pleistocene at Spanish Bight and Pacific Beach, San Diego.

*Living.*—Panama, Central America (Carpenter).

*Pleistocene.*—San Pedro; San Diego (Arnold).

### 349. Crepidula rugosa *Nuttall.*

*Crepidula rugosa* NUTT., mss., Proc. Zool. Soc., 1856, p. 224. CPR., Brit. Assn. Rept., 1863, p. 654. TRYON, Man. Conch., Vol. VIII, p. 128, Pl. XXXVII, fig. 37, 1886. KEEP, West Coast Shells, p. 76, 1892.

*Crepidula onyx* SBY. var. *rugosa* NUTT., WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 203.

Shape of shell similar to *C. onyx*, but more arched; apex prominent, submarginal, sharp, hooked, smooth, turned only slightly to one side; lines of growth irregular; surface rugose, and quite glossy in some specimens; aperture oval; margin thin; deck deeply sunken in shell, and line of contact with shell very distinct; edge of deck straight.

*Dimensions.*—Long. 20 mm.; lat. 12 mm.; alt. 10 mm.; aperture 15.5 mm. x 12 mm.

Distinguishable from *C. onyx* by more prominent apex, which is further from the margin than in the latter; by the deeper set deck and by the less prominent lines of growth. Smaller than *C. onyx*. This specimen was identified by Dr. Dall.

Found in lower San Pedro series of Deadman Island and San Pedro; and in the upper San Pedro series of Crawfish George's, Deadman Island, San Pedro, Los Cerritos, and Long Beach.

*Living.*—Santa Barbara to San Diego (Cooper): Mexico to Peru ? (Cooper).

*Pleistocene.*—Santa Barbara to San Diego (Cooper): San Pedro (Arnold).

## Family LXXVII. AMALTHEIDÆ.

### Genus **Hipponyx** *De France.*

Shell thick, obliquely conical, non-spiral; apex somewhat posterior and curved backwards; muscular impression horseshoe-shaped; base of attachment shelly, secreted by the foot of the animal.

*Hipponyx cornucopiæ* Lam. is a characteristic species.

### 350. Hipponyx antiquatus *Linnæus.*

*Patella antiquatus* LINN., Syst. Nat., Ed. XII, p. 1259, 1768. DILLW., p. 1035, No. 44, 1760.
*Hipponyx antiquatus* LINN., MENKE, Zeit. f. Mal., p. 79, 1853. CPR., Proc. Zool. Soc., 1856, p. 3; Brit. Assn. Rept., 1863, p. 654. TRYON, Man. Conch., Vol. VIII, p. 134, Pl. XL, figs. 93–99, 1886. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 244. KEEP, West Coast Shells, p. 74, fig. 59, 1892.
*Concholepas antiquatus* LINN., H. & A. ADAMS, Gen. Rec. Moll., Vol. I, p. 373, 1853.

Shell obliquely conical; apex blunt, projecting beyond posterior margin of shell; surface roughened by prominent lamellar, concentric lines of growth; base ovate; rim smooth, not crenated.

This is a very variable species, the specimen described having an unusually elevated apex. The specimen was identified by Dr. Dall.

Carpenter believes the *Hipponyx mitrula* of the West Indian fauna to be identical with the *Hipponyx antiquatus* of the Pacific Panama region. If these two are identical it is another case of an old species which has lived on in both habitats, having changed but little since the two regions were connected by water; or else it is a case of parallel development, where two species, having come from a common stock and living among like conditions, though separated geographically, have developed along parallel lines and are enough alike at the present time to warrant their being called the same species. In such a genus as *Hipponyx*, where there are so many mutations in a single species, either case would be possible.

One specimen from the lower San Pedro series of Deadman Island; also found in the Pliocene of Deadman Island.

*Living.*—Bodega Bay and south; South America; Atlantic (Cooper).

*Pleistocene.*—San Pedro (Cooper; Arnold).

### 351. Hipponyx cranioides *Carpenter.*

*Hipponyx cranioides* CPR., Ann. & Mag. Nat. Hist., 3rd Ser., Vol. XIII, 1863, p. 428. TRYON, Man. Conch., Vol. VIII, p. 135, Pl. XL, figs. 6, 7, 1886. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 244.

Shell obliquely conical, depressed; apex inconspicuous, blunt, posterior to center, but not reaching margin; surface ornamented with several wide lamellæ of growth which are grooved by numerous radiating furrows; aperture ovate; rim thin, sometimes corrugated near outer edge; interior smooth.

*Dimensions.*—Long. 19 mm.; lat. 17 mm.; alt. 6 mm.

Distinguishable from *H. antiquatus* by depressed shell, more central apex, and more regular lamellæ of growth, which are prominently radially furrowed. The specimen described was identified by Dr. Dall.

According to Tryon *H. tumens* equals *H. cranioides.*

Rather common in the lower San Pedro series at Deadman Island and San Pedro; rare in upper San Pedro series at Deadman Island and Los Cerritos. Found also in the Pleistocene at Spanish Bight, San Diego.

*Living.*—Straits of Fuca to Santa Barbara (Cooper).

*Pleistocene.*—Santa Barbara (Cooper): San Pedro; San Diego (Arnold).

### 352. Hipponyx tumens *Carpenter.*

*Hipponyx tumens* CPR., Brit. Assn. Rept., 1863, p. 654; Ann. & Mag. Nat. Hist., 3rd Ser., Vol. XV, 1865, p. 181.

*Capulus tumens* CPR., COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 232.

Shell of medium size, tumid, with oval base; apex distinct, small, sharp, curved to right side, raised above margin; surface sculptured by numerous sharp, distinct, raised radiating lines and less prominent lines of growth, which give the radiating lines a slightly granulose appearance; aperture oval, slightly effuse, and finely crenulated on outer border.

*Dimensions.*—Long. (including apex) 11.5 mm.; lat. 10 mm.; alt. 5 mm.

Distinguishable from *H. antiquatus* by its rather faint, regular sculpture, of which the radiating lines are much more prominent than the concentric.

One specimen from the lower San Pedro series of Deadman Island; also found in lower San Pedro series at San Pedro; and in the upper San Pedro series at Deadman Island. Found also in the Pleistocene at Pacific Beach, San Diego.

*Living.*—Monterey to San Diego and Islands (Cooper).

*Pleistocene.*—San Pedro (Cooper; Arnold): San Diego (Arnold).

## Family LXXVIII. NATICIDÆ.

### Genus **Natica** (*Adanson*) *Scopoli.*

Shell subglobular; spire slightly elevated; aperture half round; a spiral columellar callus entering the umbilicus.

*Natica canrena* Linn. is a characteristic species.

### Subgenus **Cryptonatica** *Dall.*

*Naticas* with smooth calcareous operculum and an umbilicus entirely and smoothly filled with callus.

Type, *Natica clausa* Brod. & Sowb.

### 353. Natica (Cryptonatica) clausa *Broderip & Sowerby.*

PLATE X, FIG. 13.

*Natica clausa* BROD. & SBY., Zool. Jour., Vol. IV, 1829, p. 360; Zool. Beechey's Voyage, p. 136, Pl. XXXIV, fig. 3; Pl. XXXVII, fig. 6, 1839. CPR., Brit. Assn. Rept., 1863, p. 661. GABB, Pal. Cal., Vol. II, p. 77, 1869. TRYON, Man. Conch., Vol. VIII, p. 30, Pl. IX, figs. 65, 67–69, 73, 1886. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 253. KEEP, West Coast Shells, p. 46, 1892.

*Natica russa* GLD., Proc. Bost. Soc. Nat. Hist., Vol. VII, 1859, p. 43; Otia, p. 109, 1862. CPR., Brit. Assn. Rept., 1863, p. 586. COOPER, Bull. No. 4, Cal. St. Min. Bureau, Part 3, 1894, p. 29.

Shell of medium size, ovate-globular; spire only slightly elevated; whorls four, evenly convex, though sometimes slightly shouldered; surface smooth except for fine incremental lines;

suture impressed, distinct; aperture semilunar; outer lip sharp; inner lip callous and reflected completely over the umbilicus.

*Dimensions.*—Alt. 27 mm.; lat. 25 mm.; aperture 20 mm. x 12.5 mm.; defl. 115 degrees.

After comparing a series of *Naticas* collected from the Pliocene of Deadman Island, part of which were identified as *N. russa* and part as *N. clausa* by Dr. Dall, it is very evident that there is no difference between the two species. This species is distinguishable from *Neverita recluziana* by a more elevated spire, more evenly convex whorls, and a more concave umbilical region.

Rare in Pliocene of Deadman Island and Timm's Point. None have been found in the Pleistocene by the writer, except one small specimen which came from the lower San Pedro series at Deadman Island. Found in the Pliocene at Packard's Hill, and in the Pleistocene at the bath-house, Santa Barbara. The specimen figured is a medium sized one from the Pliocene of Deadman Island, and is now in the collection of Delos Arnold.

*Living.*—Arctic Ocean; Alaska; North Atlantic (Cooper).

*Pleistocene.*—Santa Barbara to San Diego (Cooper): San Pedro; Santa Barbara (Arnold).

*Pliocene.*—San Pedro; Santa Barbara (Arnold).

## Genus **Polynices** *Montfort.*

This group includes all of the Naticidæ with corneous opercula.
Type, *Natica mammilla* Linn.

## Subgenus **Neverita** *Risso.*

Shell depressed, orbicular; spire conical or flattened; columella partly filled by a tongue-shaped callous process (funiculum) from the columella. Operculum horny.

*Natica duplicata* Say is a characteristic species.

### 354. **Polynices (Neverita) recluziana** *Petit.*

PLATE X, FIG. 12.

*Natica recluziana* PETIT, DESHAYES, Mag. de Zool., Mollusca, p. 37, 1841. TRYON, Man. Conch., Vol. VIII, p. 34, Pl. XII, fig. 1, 1886.

*Neverita recluziana* PETIT, H. & A. ADAMS, Gen. Rec. Moll., Vol. I, p. 208, 1853. CPR., Brit. Assn. Rept., 1863, p. 661. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 254. KEEP, West Coast Shells, p. 46, fig. 26, 1892. WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 211.

*Neverita recluziana* DESH., GABB, Pal. Cal., Vol. II, p. 77, 1869. DALL, Trans. Wagner Inst. Sci., Vol. III, Part 2, 1892, p. 369.

Shell ovate to flattened globular; spire only very slightly elevated, obtuse; whorls three, slightly convex; body-whorl having a long, slightly convex slope from suture to near base, where it

suddenly turns under to umbilicus; surface ornamented with fine, oblique incremental lines; suture distinct, but not impressed; aperture semilunar; lip thin; columella incrusted, the incrustation extending down and completely covering the umbilicus.

*Dimensions.*—Long. 20 mm.; lat. 24 mm.; aperture 16 mm. x 10 mm.; defl. 130 degrees. (A rather small specimen.)

The young shells are more depressed than the adults, some of them being quite flat. In some of the specimens the callus has not completely covered the umbilicus, leaving a little pit near the lower part of the umbilical region. This species is very variable in both size and shape. Dr. Dall has described a variety with an elevated spire which he calls var. *alta*. This variety is quite common in all of the upper San Pedro series localities.

Common in the upper San Pedro series of the San Pedro region, but rare in the lower San Pedro series and Pliocene. Found in the Pleistocene at Barlow's ranch and old irrigating ditch, Ventura; at Spanish Bight, Twenty-sixth Street, and Pacific Beach, San Diego; and in the Pliocene at Pacific Beach, San Diego. The specimen figured is from the upper San Pedro series at San Pedro, and is now in the collection of Delos Arnold.

*Living.*—Monterey to Lower California (Cooper).

*Pleistocene.*—Santa Barbara to San Diego (Cooper): San Pedro; Santa Barbara; San Diego (Arnold).

*Pliocene.*—Santa Barbara; San Fernando (Cooper): San Pedro; San Diego (Arnold): San Diego well (Dall).

*Miocene.*—Martinez; Walnut Creek; Santa Inez; Santa Monica; Death Valley (Cooper).

Subgenus **Lunatia** *Gray.*

Shell usually somber colored; covered with a dark, thin epidermis; not so thick as the typical group; umbilicus open, without funiculum. Operculum corneous.

Type, *Natica ampullaria* Lam.

### 355. Polynices (Lunatia) lewisii *Gould.*

PLATE X, FIG. 14.

*Natica lewisii* GLD., Proc. Bost. Soc. Nat. Hist., 1847, p. 239; Wilkes' Expl. Exped., p. 211, Pl. XV, p. 253, 1852.

*Lunatia lewisii* GLD., CPR., Brit. Assn. Rept., 1863, p. 661. GABB, Pal. Cal., Vol. II, p. 77, 1869. = *N. reiniana* DUNKER (young), = *N. algida* GLD. (*fide* TRYON, Man. Conch., Vol. VIII, p. 35, Pl. XIII, figs. 11, 12; Pl. IX, fig. 70, 1886). COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 247. KEEP, West Coast Shells, p. 45, fig. 25, 1892. DALL, Trans. Wagner Inst. Sci., Vol. III, Part II, 1892, p. 374.

*Natica (Lunatia) lewisii* GLD., WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 211.

The adult may be distinguished from *Neverita recluziana* by its large size, open umbilicus, generally more elevated spire, and a shallow, spiral groove near the

anterior portion of the body-whorl. The upper whorls are more convex and more distinctly separated from each other by the suture than are the upper whorls of the latter species. All the specimens found were larger than the average *N. recluziana*, some of them being over 100 mm. in altitude.

Rare in the upper San Pedro series of San Pedro, Los Cerritos, Long Beach, Crawfish George's, and Deadman Island. The specimen figured is from the upper San Pedro series at San Pedro, and is now in the collection of Delos Arnold.

*Living.*—Straits of Fuca to San Diego (Cooper): Japan (Tryon): Catalina Island (Arnold).

*Pleistocene.*—Santa Barbara; San Nicolas Island (Cooper): San Pedro (Arnold).

*Pliocene.*—Kirker's Pass; Santa Barbara; San Fernando (Cooper): Soquel, Santa Cruz County (Arnold).

### Genus **Sigaretus** *Lamarck.*

Shell ear-shaped, with minute spire and very large aperture; externally with revolving striæ; color usually white, with sometimes a thin, corneous epidermis. Operculum minute, horny, subspiral.

*Sigaretus neritoideus* Linn. is a characteristic species.

### 356. **Sigaretus debilis** *Gould.*

*Sigaretus debilis* GLD., Jour. Bost. Soc. Nat. Hist., Vol. VI, 1853, p. 379, Pl. XIV, fig. 17. CPR., Proc. Zool. Soc., 1856, p. 207. TRYON, Man. Conch., Vol. VIII, p. 57, Pl. XXIV, fig. 65, 1886. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 264. KEEP, West Coast Shells, p. 47, 1892.

"Shell small, much depressed, thin, almost pellucid; whorls two, spire almost coincident with the general surface; apex at one-fourth the diameter of the shell; periphery obtuse-angular, becoming more so as it approaches the aperture; ventral surface excavated at the umbilical region, with a slight unappressed lamina at that point; margin of the aperture having a very slight advance in the outline, as it approaches the peripheral angle; surface with very numerous and very delicate obtusely excavated revolving striæ, much finer on the ventral than on the dorsal surface."

*Dimensions.*—Length about 22 mm.

The above is Gould's original description.

Rare in the upper San Pedro series; one imperfect specimen from that horizon at Los Cerritos, and one nearly perfect one from the lumber yard, San Pedro.

*Living.*—Monterey to Lower California (Cooper).

*Pleistocene.*—San Pedro (Arnold).

*Pliocene.*—San Diego well (Cooper).

## Family LXXIX. LAMELLARIIDÆ.

### Genus **Lamellaria** *Montagu.*

Shell ear-shaped; thin, pellucid, fragile; spire very small; aperture large, patulous; inner lip receding.

*Lamellaria perspicua* is a characteristic species.

#### 357. **Lamellaria stearnsii** *Dall.*

*Lamellaria stearnsii* DALL, Am. Jour. Conch., Vol. VII, 1872, p. 122, Pl. XV, fig. 6. TRYON, Man. Conch., Vol. VIII, p. 63, Pl. XXVII, figs. 12 and 13, 1886. KEEP, West Coast Shells, p. 47, fig. 27, 1892. DALL, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 211.
*Lamellaria depressa* DALL, mss., 1866 (*fide* DALL).

Shell suborbicular, depressed; spire hardly elevated above last whorl; whorls three, convex; columella sharp, thin, widely arcuate, loosely twisted, so that the apex is discernible from below; suture distinct; aperture very effuse, rounded; marked by lines of growth, crossed by microscopic fine revolving striæ.

*Dimensions.*—Long. 15.2 mm.; lat. 11 mm.; alt. 7 mm.

Somewhat resembles *Sigaretus debilis*, but smaller, smoother, and more inflated.

Rare in lower San Pedro series of Deadman Island; one specimen. Found also in the Pleistocene at Twenty-sixth Street, San Diego.

*Living.*—Monterey (Dall): San Pedro (Williamson): West Coast (Keep).

*Pleistocene.*—San Pedro; San Diego (Arnold).

## Superfamily DOCOGLOSSA.

## Family LXXX. ACMÆIDÆ.

### Genus **Acmæa** *Eschscholtz.*

Shell solid, patuliform; apex erect or anteriorly inclined.

*Acmæa mitra* Esch. is a characteristic species.

#### 358. **Acmæa depicta** *Hinds.*

*Patelloida depicta* HDS., Ann. Nat. Hist., Vol. X, 1842, p. 82; Voyage Sulphur, p. 53, No. 217, 1844.
*Nacella depicta* HDS., Proc. Zool. Soc., 1856, p. 204. CPR., Brit. Assn. Rept., 1863, p. 650. KEEP, West Coast Shells, p. 103, 1892.

Shell small, conical, with elongate-elliptical base; apex inconspicuous, about one-fifth length from posterior extremity; surface ornamented by radiating narrow bands of color.

*Dimensions.*—Long. 7 mm.; lat. 2.8 mm.; alt. 1.8 mm.

This species is close to *A. paleacea*, but is slightly broader, more depressed, and has bands of brown radiating from the apex.

One specimen from the upper San Pedro series at Crawfish George's.

*Living.*—San Diego (Carpenter).

*Pleistocene.*—San Pedro (Arnold).

### 359. Acmæa insessa *Hinds.*

*Patella insessa* HDS., Ann. & Mag. Nat. Hist., Vol. X, 1860, p. 82, Pl. VI, fig. 3.
*Nacella incessa* HDS., CPR., Brit. Assn. Rept., 1863, p. 650. GABB, Pal. Cal., Vol. II, p. 87, 1869. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 227. KEEP, West Coast Shells, p. 103, fig. 91, 1892.
*Acmæa insessa* HDS., DALL, Am. Jour. Conch., Vol. VI, 1871, p. 244, Pl. XIV, fig. 3. TRYON, Man. Conch., Vol. XIII, p. 18, Pl. VI, figs. 36, 37, 1891. WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 197.

Shell limpet-shaped, rather thick, brown; apex acute and dark, with light band around dark spot (this coloration due to the wearing of shell through outer layer); sculpture consists of fine incremental striæ; margin inclined to be compressed as the shell grows old; apex slightly anterior.

*Dimensions.*—Long. 17 mm.; lat. 10 mm.; alt. 11 mm.

Found in the Pliocene of Deadman Island; the lower San Pedro series of Deadman Island and San Pedro; and the upper San Pedro series of Deadman Island, San Pedro, Los Cerritos, and Crawfish George's. Found in the Pleistocene at bath-house, Santa Barbara; and at Spanish Bight, San Diego.

*Living.*—Sitka to San Diego (Dall).

*Pleistocene.*—San Diego (Cooper): San Pedro; Santa Barbara; San Diego (Arnold).

*Pliocene.*—San Pedro (Arnold).

### 360. Acmæa instabilis *Gould.*

*Patella instabilis* GLD., Proc. Bost. Soc. Nat. Hist., Vol. II, 1846, p. 150.
*Nacella instabilis* GLD., CPR., Brit. Assn. Rept., 1863, p. 650. KEEP, West Coast Shells, p. 103, 1892.
*Acmæa instabilis* GLD., DALL, Am. Jour. Conch., Vol. VI, 1871, p. 245. TRYON, Man. Conch., Vol. XIII, p. 18, Pl. VI, figs. 32, 33, 1891. COOPER, Bull. No. 4, Cal. St. Min. Bureau, Part III, 1894, p. 24.

Shell resembles *A. insessa*, but is much larger when adult; apex rounded; sculpture consists of concentric grooves and striæ.

*Dimensions.*—Long. 26.5 mm.; lat. 15 mm.; alt. 12 mm.

Distinguishable from *A. insessa* by its rounded apex, shallowness, and larger size. One specimen from upper San Pedro series of Crawfish George's.

*Living.*—Sitka to Monterey (Dall).

*Pleistocene.*—San Pedro (Arnold): San Nicolas Island (Bowers).

### 361. Acmæa mitra *Eschscholtz.*

*Acmæa mitra* ESCH., Zool. Atlas, Vol. V, p. 18, No. 1, Pl. XXIII, fig. 4, 1833. DALL, Am. Jour. Conch., Vol. VI, 1871, p. 241, Pl. XIV, fig. 1. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 228. TRYON, Man. Conch., Vol. XIII, p. 24, Pl. III, fig. 50, 1891. KEEP, West Coast Shells, p. 99, fig. 85, 1892. WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 197.
*Scurria mitra* ESCH., CPR., Brit. Assn. Rept., 1863, p. 650. GABB, Pal. Cal., Vol. II, p. 87, 1869.

Shell conical, apex erect, nearly central, rather sharp, smooth; posterior surface straight; anterior slightly convex; ornamentation of fine incremental lines, giving quite a rough surface to some specimens; aperture oval to nearly circular; rim smooth.

*Dimensions.*—Long. 31 mm.; lat. 27.5 mm.; alt. 19 mm.

Easily distinguishable by its elevated, nearly central apex, comparatively smooth, light colored surface, and its size.

Not uncommon in the upper San Pedro series of Crawfish George's.

*Living.*—Sitka to San Diego (Cooper): Half Moon Bay, San Mateo County (Arnold).

*Pleistocene.*—Santa Barbara to San Diego (Cooper): San Pedro (Arnold).

### 362. Acmæa paleacea *Gould.*

*Acmæa paleacea* GLD., Bost. Jour. Nat. Hist., Vol. VI, 1853, p. 376, Pl. XIV, fig. 5; Mex. and Cal. Shells, p. 3, Pl. XIV, fig. 5, 1853. DALL, Am. Jour. Conch., Vol. VI, 1871, p. 253. TRYON, Man. Conch., Vol. XIII, p. 20, Pl. VI, fig. 42, 1891. WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 197.

*Nacella paleacea* GLD., CPR., Brit. Assn. Rept., 1863, p. 650. KEEP, West Coast Shells, p. 104, 1892.

"Shell minute, delicate, thin, elongated, laterally compressed, so that the two sides are parallel; dorsal aspect a long, narrow oval; lateral aspect low, triangular; apex at about the anterior third, acute, antrorse; surface with delicate lines of growth and a few obtuse radiating ridges along the dorsal slope at each end; color cinnamon brown."

*Dimensions.*—Long. 7 mm.; lat. 1.5 mm.; alt. 2 mm.

This shell has little resemblance to any of the others of its genus found in this formation, and may readily be distinguished by its small size and peculiar shape. Dr. Dall identified the specimen.

Rare in the upper San Pedro series of Crawfish George's; two specimens found.

*Living.*—Santa Barbara (Jewett): Monterey; San Diego (Dall).

*Pleistocene.*—San Pedro (Arnold).

### 363. Acmæa pelta *Eschscholtz.*

*Acmæa pelta* ESCH., Zool. Atl., Vol. V, p. 19, No. 5, 1833. CPR., Brit. Assn. Rept., 1863, p. 650. GABB, Pal. Cal., Vol. II, p. 52, 1869. DALL, Am. Jour. Conch., Vol. VI, 1871, p. 246, Pl. XIV, fig. 6. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 228. TRYON, Man. Conch., Vol. XIII, p. 17, Pl. VIII, figs. 86-95, 1891. KEEP, West Coast Shells, p. 102, 1892. WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 197.

Shell depressed, rounded, with few prominent bulging ribs, which are not developed in the young shell; apex smooth, obtuse, and anterior to center.

Two specimens sent to Dr. Dall were identified by him as the young of this species.

Rare in the lower San Pedro series of Deadman Island; and upper San Pedro series of Los Cerritos and San Pedro. Found in the Pleistocene at Pacific Beach, San Diego; and at Barlow's ranch, Ventura.

*Living.*—Sitka to San Diego (Cooper).

*Pleistocene.*—Santa Barbara (Cooper): San Pedro; Ventura; San Diego (Arnold).

### 364. Acmæa spectrum (*Nuttall*) *Reeve*.

*Acmæa spectrum* NUTT., RVE., CPR., Brit. Assn. Rept., 1863, p. 650.
*Acmæa spectrum* NUTT., GABB, Pal. Cal., Vol. II, p. 86, 1869. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 228. KEEP, West Coast Shells, p. 100, figs. 86, 87, 1892. WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 197.
*Acmæa spectrum* RVE., DALL, Am. Jour. Conch., Vol. VI, 1871, p. 251, Pl. XIV, fig. 10. TRYON, Man. Conch., Vol. XIII, p. 14, Pl. I, figs. 7–9, 1891.

Shell depressed, with rather acute apex, which is about one-third length of shell from the anterior margin; ribs very prominent and rugose, generally alternating large and small.

*Dimensions.*—Long. 26 mm.; lat. 19 mm.; alt. 10 mm.

The commonest of the Acmædæ, and easily distinguishable by the prominent, rugose ribs.

Rare in the lower San Pedro series of Deadman Island; and rather common in the upper San Pedro series of Deadman Island and San Pedro.

*Living.*—Bodega Bay to Lower California (Dall).

*Pleistocene.*—Santa Barbara; San Pedro (Cooper): San Pedro (Arnold).

## Family LXXXI. LIOTIIDÆ.

### Genus **Delphinoidea** *Brown*.

Shell orbicular, depressed, widely umbilicated; spire short; whorls transversely striated or cancellated; aperture round, not nacreous; peristome continuous, simple.

*Delphinoidea cancellata* Marryat is a characteristic species.

### [S. D.] **Delphinoidea coronadoensis,** sp. nov.

Shell minute, orbicular, depressed, milk-white, rather thick for size of shell; spire flattened beneath plane of upper periphery of the body-whorl; whorls two and one-half, nearly circular in cross-section; surface ornamented by numerous subequal, rounded spiral ridges, and very minute transverse lines, the whole giving the surface a cancellated appearance; irregular lines denoting interruption in growth are common on the body-whorl; suture deeply appressed; umbilicus wide, deep; aperture suboval; peristome continuous, rather thick, slightly effuse.

*Dimensions.*—Maximum diam. 2 mm.; alt. 0.9 mm.

This species, which is the smallest gastropod found in the Spanish Bight Pleistocene, is named for the Coronado peninsula, into which Spanish Bight extends.

*Pleistocene.*—San Diego (Arnold).

## Family LXXXII. PHASIANELLIDÆ.

### Genus **Phasianella** *Lamarck.*

Shell elongated, polished, richly colored; whorls convex; aperture oval, not pearly; inner lip callous; outer lip thin; operculum shelly; callous outside, subspiral inside.

*Phasianella fulimoides* Lam. is a characteristic species.

### 365. **Phasianella compta** *Gould.*

*Phasianella compta* GLD., Pac. R. R. Rept., Vol. VI, p. 333, Pl. XI, figs. 25, 26, 1857. CPR., Brit. Assn. Rept., 1863, p. 651. GABB, Pal. Cal., Vol. II, p. 82, 1869. TRYON, Man. Conch., Vol. X, p. 173, Pl. XXXIX, figs. 69–72, 1888. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 258. KEEP, West Coast Shells, p. 89, fig. 74, 1892. WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 199.

Shell small, thin; spire elevated; apex subacute; whorls four, evenly convex; ornamentation consists of eight obsolete spiral ridges crossed by numerous fine oblique, incremental lines; suture depressed, distinct; aperture ovate; outer lip thin; inner lip sharp and effuse, with incrustation extending to umbilical region; a narrow umbilical chink is sometimes present.

*Dimensions.*—Long. 9.5 mm.; lat. 6 mm.; body-whorl 7 mm.; aperture 4.2 mm. x 2.8 mm.; defl. 45 degrees.

Distinguishable from the genus *Lacuna* by lack of distinct umbilical chink, and by the spiral lines. These lines are slightly oblique and slope anteriorly from the top of the whorl. The Pleistocene shells often retain their coloration of zigzag, irregular, transverse, purple lines.

This species is common in the upper San Pedro series of San Pedro; and in the lower San Pedro series at San Pedro and Deadman Island. Found also in the Pleistocene at Twenty-sixth Street, San Diego.

*Living.*—San Pedro to Mazatlan (Cooper).

*Pleistocene.*—San Pedro; San Diego (Cooper; Arnold).

## Family LXXXIII. TURBINIDÆ.

### Genus **Pachypoma** *Gray.*

Shell trochiform, conical, with moderately elevated spire; base concave, not umbilicated; whorls flattened, rugose, spinously fringed. Operculum oval, subquadrangular, externally convex.

*Pachypoma cælata* Chem. is a characteristic species.

### 366. **Pachypoma inæquale** *Martyn.*

*Trochus inæqualis* MART., Univ. Conch., Lond., 1784.

*Pachypoma inæquale* MART., DALL, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 199, Pl. XXIII, figs. 1, 3, 5.

*Trochus gibberosus* CHEM., Conch. Cab., X, p. 278, vign. 23, 1795.

*Pachypoma gibberosum* CHEM., CPR., Brit. Assn. Rept., 1863, p. 651. GABB, Pal. Cal., Vol. II, p. 83, 1869. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 256. KEEP, West Coast Shells, p. 87, 1892.

*Astralium inæquale* MART., TRYON, Man. Conch., Vol. X, p. 244, Pl. LVII, figs. 51, 52, 1888.

Shell of moderate size, conical; spire elevated, subacute; whorls five or six, flat, with numerous oblique, rounded, irregular, transverse ridges, with smaller ridges intercalated on lower part of whorls; suture impressed, wavy, distinct; aperture subovate; umbilicus obsolete; base flat, ornamented with several prominent, rounded, rugose spiral ridges with squamose lirulæ between.

*Dimensions.*—Alt. 23 mm.; lat. 25 mm.; defl. 65 mm.

This species resembles *Pomaulax undosus* quite closely, but may be distinguished from that species by lack of prominent keel on anterior margin of whorl, intercalated transverse ridges, and prominent spiral ridges on base.

Rare in upper San Pedro series of San Pedro.

*Living.*—Straits of Fuca to Catalina Island (Cooper).

*Pleistocene.*—Santa Barbara; San Pedro (Cooper): San Pedro (Williamson; Arnold).

Genus **Pomaulax** *Gray.*

Shell trochiform, elevated, conic, angulated and nodose at the periphery; obliquely ribbed; not umbilicated; inner lip arcuated with a wide callus, which is channeled, anteriorly truncated.

Type, *Pomaulax undosus* Wood.

### 367. Pomaulax undosus *Wood.*

*Trochus undosus* Wood, Index, Test. Suppl., Pl. LI, fig. 1, 1828; Suppl., p. 16, Pl. V, fig. 1, 1859.
*Pomaulax undosus* Wood, Cpr., Brit. Assn. Rept., 1863, p. 651. Gabb, Pal. Cal., Vol. II, p. 83, 1869. Tryon, Man. Conch., Vol. X, p. 243, Pl. LVIII, figs. 69, 70, 1888; Syst. and Struct. Conch., Vol. II, p. 308, Pl. LXXX, fig. 33, 1883. Cooper, 7th Ann. Rept. Cal. St. Min., 1888, p. 260. Keep, West Coast Shells, p. 89, fig. 75, 1892. Williamson, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 199.

Shell large, conical; spire elevated, subacute; whorls six or seven, flat with undulating, nodose keel on anterior margin; transverse ridges on upper part of whorl, with small nodes near middle of shell and toward anterior margin; suture appressed, distinct and wavy; keel prominent on body-whorl; base flat, with faint spiral sculpture; aperture subovate; columellar protuberance on some specimens.

*Dimensions.*—Alt. 40 mm.; lat. 45 mm.; defl. 70 degrees.

This species is characterized by the prominent nodose keel on anterior margin of whorl. Although the living specimens are common, the fossils are rare in this locality.

Upper San Pedro series of San Pedro and Crawfish George's. Found also in the Pleistocene at Pacific Beach, San Diego.

*Living.*—Santa Barbara to Cape St. Lucas; Monterey ? (Cooper).

*Pleistocene.*—Santa Barbara to San Diego (Cooper): San Pedro; San Diego (Arnold).

Genus **Leptothyra** *Carpenter.*

Shell small, turbinated, thick; not umbilicated; aperture circular, slightly angulated anteriorly.

Type, *Leptothyra carpenteri* Carpenter.

### 368. Leptothyra bacula *Carpenter.*

*Leptonyx bacula* CPR., Brit. Assn. Rept., 1863, p. 652. KEEP, West Coast Shells, p. 87, 1892.
*Leptothyra bacula* CPR., GABB, Pal. Cal., Vol. II, p. 85, 1869. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 245. WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 199.

Shell small, turreted, thick; surface sculptured by fine spiral lines; no umbilicus; aperture circular, slightly angulated anteriorly.

*Dimensions.*—Alt. 2 mm.; lat. 2.5 mm.

The specimen from the Pleistocene shows the original pink color of the living shell, and looks very much like a very small *Norrisia norrisii*, except that the *Leptothyra* has no umbilicus.

Distinguishable from *L. carpenteri* and *L. paucicostata* by its much finer spiral sculpture and pinkish color.

One specimen from the lower San Pedro series of Deadman Island; also found in the lower San Pedro series at Los Cerritos. Found in the Pleistocene at bath-house, Santa Barbara.

*Living.*—Monterey to Catalina Island (Cooper).

*Pleistocene.*—Santa Barbara to San Pedro (Cooper): San Pedro; Santa Barbara (Arnold).

### 369. Leptothyra carpenteri *Pilsbry.*

*Leptothyra carpenteri* PILSBRY, TRYON, Man. Conch., Vol. X, p. 247, Pl. XXXIX *a*, figs. 26–29, 1888; Nautilus, July, 1890. WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 199.
*Leptothyra sanguineus* LINN., CPR., Brit. Assn. Rept., 1863, p. 652.
*Leptothyra sanguinea* CPR., GABB, Pal. Cal., Vol. II, p. 85. 1869. TRYON, Syst. Conch., Vol. I, Pl. II, p. 312, 1882. COOPER, 7th Ann. Rept. Cal. St. Min., p. 245, 1888. (Not *Leptothyra sanguineus* LINN., Syst. Nat., 1760.)
*Leptonyx sanguinea* LINN., KEEP, West Coast Shells, p. 87, fig. 73, 1892.

Shell small, subconical, thick; spire only slightly elevated; whorls three to four, slightly convex; body-whorl subangulate anteriorly; whorls ornamented by nine to ten fine, spiral ridges; aperture circular; not umbilicated; tubercle on lower portion of outer lip; suture slightly impressed, distinct.

*Dimensions.*—Alt. 8 mm.; lat. 10 mm.; defl. 100 degrees.

Distinguishable from *L. paucicostata* by larger size, greater number and less prominence of spiral ridges, and by less prominence of suture; distinguishable from *L. bacula* by less number and greater prominence of spiral ridges.

Found in lower San Pedro series at Deadman Island, and San Pedro; and in the upper San Pedro series at San Pedro and Crawfish George's.

*Living.*—Straits of Fuca to San Diego; Japan (Cooper).

*Pleistocene.*—Santa Barbara (Cooper): San Pedro (Arnold).

### 370. Leptothyra paucicostata *Dall.*

*Leptothyra paucicostata* DALL, Am. Jour. Conch., Vol. VII, 1872, p. 131, Pl. XV, fig. 10. TRYON, Man. Conch., Vol. X, p. 248, Pl. LXIII, fig. 27, 1888. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 245.

Shell smaller than *L. carpenteri;* whorls ornamented with very prominent, coarse spiral ridges; a typical specimen showing six on the body-whorl and two small ones in umbilical region; suture deeply impressed, distinct; aperture circular; lip thick, with tubercle on lower part.

*Dimensions.*—Alt. 4 mm.; lat. 5 mm.; defl. 100 degrees.

Distinguishable from *L. carpenteri* and *L. bacula* by the coarse spiral ribs and deep suture.

Two specimens found in the lower San Pedro series of San Pedro. Found in the Pleistocene at the bath-house, Santa Barbara.

*Living.*—Santa Cruz to Monterey (Cooper).

*Pleistocene.*—Santa Barbara (Cooper): San Pedro; Santa Barbara (Arnold).

## Family LXXXIV. TROCHIDÆ.

### Genus **Chlorostoma** *Swainson.*

Shell conoidal, profoundly umbilicated, or umbilical region covered by a callosity; whorls smooth or subcarinated, the last subangulated at the base; columellar lip spirally twisted around the umbilicus; outer lip angulated at the base.

*Chlorostoma argyrostroma* Chemn. is a characteristic species.

#### 371. **Chlorostoma aureotinctum** *Forbes.*

*Trochus aureotinctus* FBS., Proc. Zool. Soc., 1850, p. 271. FISCHER, Coq. Viv., *Turbo*, p. 94, Pl. XXXI, fig. 1.

*Chlorostoma aureotinctum* FBS., CPR., Brit. Assn. Rept., 1863, p. 652. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 234. TRYON, Man. Conch., Vol. XI, p. 172, Pl. XXVII, figs. 31–33, 1889. KEEP, West Coast Shells, p. 84, 1892. WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 200.

Shell conoidal, spire somewhat elevated; apex obtuse; whorls four, slightly convex; body-whorl subangular at base; surface roughened by prominent, rounded, irregular, transverse ridges, which appress against the antecedent whorls and become obsolete at the angles of the whorl; lower portion of whorl smooth, as is the whole surface of the two posterior whorls; suture distinct; base of body-whorl furrowed with four grooves which show transverse incremental lirulæ at their bottoms; umbilicus deep and effuse, with bright, yellow stain in the living shell; aperture circular; columellar lip slightly twisted around umbilicus; outer lip with two small tubercles on inner side of base.

*Dimensions.*—Alt. 10 mm.; lat. 17.5 mm.; defl. 100 degrees.

Rare in upper San Pedro series of San Pedro.

*Living.*—Santa Barbara to Lower California (Cooper).

*Pleistocene.*—Santa Barbara (Cooper): San Pedro (Arnold).

#### 372. **Chlorostoma brunneum** *Philippi.*

*Trochus brunneus* PHIL., Zeits. Monog. Troch., p. 300, Pl. XLIII, fig. 19, 1848. LISCHKE, Jap. Meers. Conchyl., p. 99. FISCHER, Coq. Viv., p. 365, Pl. CXII, fig. 1.

*Chlorostoma brunneum* PHIL., CPR., Brit. Assn. Rept., 1863, p. 652. GABB, Pal. Cal., Vol. II, p. 84, 1869. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 234. TRYON, Man. Conch., Vol. XI, p. 170, Pl. XXVII, figs. 36–38, 1889. KEEP, West Coast Shells, p. 83, fig. 69, 1892. WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 200, Pl. XXI, fig. 8.

Shell conoidal, thick; whorls six, slightly convex; slight shoulder posteriorly near suture; ornamentation consists of numerous prominent, fine, oblique, incremental lines; suture impressed, distinct; umbilicus obsolete; base flat; obsolete spiral ornamentation; outer lip thin, effuse.

*Dimensions.*—Long. 28 mm.; lat. 28 mm.; defl. 65 degrees.

Distinguishable from *C. montereyi*, which it resembles in shape, by more convex whorls, obsolete umbilicus and lack of spiral ornamentation.

This species is rare in the Pliocene of Deadman Island, and in the upper San Pedro series of Deadman Island and Crawfish George's.

*Living.*—Cape Mendocino to San Diego (Cooper): Japan ? (Tryon).

*Pleistocene.*—Santa Barbara Island (Cooper): San Pedro (Arnold).

*Pliocene.*—San Pedro (Arnold).

### 373. Chlorostoma funebrale *A. Adams.*

*Chlorostoma funebrale* A. AD., Proc. Zool. Soc., 1854, p. 316. CPR., Brit. Assn. Rept., 1863, p. 652. GABB, Pal. Cal., Vol. II, p. 84, 1869. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 234. TRYON, Man. Conch., Vol. XI, p. 170, Pl. XXVIII, figs. 42-44, 1889. KEEP, West Coast Shells, p. 84, fig. 71, 1892. WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 200, Pl. XXI, fig. 7.

*Trochus funebralis* A. AD., FISCHER, Coq. Viv., p. 173, Pl. LVII, fig. 3.

Shell conoidal, thick, black; whorls five, only slightly convex; ornamentation of eight spiral ridges crossed by fine, oblique lirulæ of growth; suture distinct; base flat; ornamentation same as whorls, with the oblique incremental lines brought into prominence, as a rule; umbilicus obsolete; outer lip effuse, with one prominent and one smaller tubercle near umbilical region; inner lip incrusted.

*Dimensions.*—Long. 18 mm.; lat. 19 mm.; defl. 74 degrees.

Distinguishable by black color, spiral ridges and obsolete umbilicus.

Rare in the lower San Pedro series of Deadman Island and San Pedro; and in upper San Pedro series of Deadman Island, San Pedro, Los Cerritos, Long Beach, and Crawfish George's. Found also in the Pleistocene at Barlow's ranch, Ventura; and at Pacific Beach, San Diego.

*Living.*—Sitka to San Diego (Cooper).

*Pleistocene.*—Santa Barbara to San Diego (Cooper): San Pedro; Ventura; San Diego (Arnold).

### 374. Chlorostoma funebrale *A. Adams,* var. subapertum *Carpenter.*

*Chlorostoma funebrale* var. *subapertum* CPR., Brit. Assn. Rept., 1863, p. 652. DALL, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 200, Pl. XXI, fig. 6.

Shell resembles *C. funebrale*, but differs in having more prominent spiral ridges, which are usually much more rugose, and in having a prominent umbilical pit.

Found in same localities as *C. funebrale.*

*Living.*—Vancouver district (Carpenter): West Coast.

*Pleistocene.*—San Pedro (Arnold).

### 375. Chlorostoma gallina *Forbes.*

*Trochus (Monodonta) gallina* FBS., Proc. Zool. Soc., 1850, p. 271, Pl. XI, fig. 8.
*Trochus gallina* FBS., FISCHER, Coq. Viv., p. 258, Pl. CXI, fig. 1.
*Chlorostoma gallina* FORBES, CPR., Brit. Assn. Rept., 1863, p. 652. TRYON, Man. Conch., Vol. XI, p. 169, Pl. XX, fig. 15; Pl. XXVIII, figs. 52 and 53, 1889. KEEP, West Coast Shells, p. 84, fig. 70, 1892. WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 200.

Shell conoidal, thick; whorls five, flat, slightly shouldered posteriorly near suture in some specimens; ornamentation consists of numerous obsolete spiral ridges, and irregular, oblique, transverse ridges of varying prominence; suture distinct; umbilicus nearly obsolete; base flat, same ornamentation as whorls; outer lip effuse, with prominent tubercle near umbilicus.

*Dimensions.*—Long. 20 mm.; lat. 21 mm.; defl. 80 degrees.

Most specimens show oblique, alternating dark and light, irregular lines, which characterize the living shells.

Rare in upper San Pedro series of San Pedro, Crawfish George's, and Deadman Island. Found in the Pleistocene at Pacific Beach, San Diego.

*Living.*—Santa Barbara Islands to Lower California (Carpenter).

*Pleistocene.*—San Pedro; San Diego (Arnold).

### 376. Chlorostoma montereyi *Kiener.*

PLATE X, FIG. 19.

*Trochus montereyi* KIENER, Species *Trochus*, Pl. XXXIII, figs. 1 and 1*a*. FISCHER, Coq. Viv., p. 104, Pl. XXXIII, fig. 1. TRYON, Man. Conch., Vol. XI, p. 171, Pl. XXVII, figs. 27, 28, 29, 1889.
*Omphalius pfeifferi* PHIL., CPR., Proc. Zool. Soc., 1856, p. 200.
*Chlorostoma pfeifferi* PHIL., CPR., Brit. Assn. Rept., 1863, p. 652. GABB, Pal. Cal., Vol. II, p. 84, 1869. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 234. KEEP, West Coast Shells, p. 83, 1892.
*Chlorostoma montereyensis* KIEN., WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 200.

Shell conical; whorls seven, flat (on some specimens the whorls have a shoulder on the posterior part); suture distinct but not impressed; surface of upper five or six whorls ornamented with five flat, spiral ridges, the space between the ridges being crossed by minute incremental lines, which slope anteriorly at quite an angle; ornamentation on the rest of the whorls indistinct; base flat, indistinctly ornamented as on the upper whorls; umbilicus open, smooth and slightly keeled aperture elliptical.

*Dimensions.*—Alt. 35 mm.; lat. 33 mm.; defl. 65 degrees.

The specimen described was identified by Dr. Dall.

Found in the Pliocene of Deadman Island; in the lower San Pedro series of Deadman Island; and in the upper San Pedro series of Deadman Island, Crawfish George's, and San Pedro. Found in the Pleistocene at Pacific Beach, San Diego. The specimen figured is from the upper San Pedro series at Crawfish George's, and is now in the collection of Delos Arnold.

*Living.*—Baulinas Bay to San Diego (Cooper).

*Pleistocene.*—Santa Barbara to San Diego (Cooper): San Pedro; San Diego (Arnold).

*Pliocene.*—San Pedro (Arnold).

### Subgenus **Omphalius** *Philippi.*

Shell convex-trochiform, umbilicated; whorls with revolving series of granules; the last whorl bluntly angulated at the periphery; umbilicus encircled by a callosity; columellar lip terminated by a tooth anteriorly, below which are small tubercles; outer lip usually internally grooved.

*Chlorostoma viridulus* Gmel. is a characteristic species.

### 377. **Chlorostoma (Omphalius) viridulum** var. **ligulatum** *Menke.*

*Trochus ligulatus* MENKE, Zeit. f. Mal., 1850, p. 173. FISCHER, Coq. Viv., p. 382, Pl. CXV, fig. 5.
*Omphalius ligulatus* MENKE, CPR., Cat. Mazatlan Shells, p 235.
*Omphalius fuscescens* PHIL., CPR., Proc. Zool. Soc., 1856, p. 224. CPR., Brit. Assn. Rept., 1863, p. 652. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 255. KEEP, West Coast Shells, p. 82, fig. 68, 1892.
*Trochus luridus* NUTT., CPR., mss., Brit. Assn. Rept., 1856, p. 233.
*Chlorostoma (Omphalius) viridulum* var. *ligulatum* MENKE, TRYON, Man. Conch., Vol. XI, p. 177, Pl. XXIX, figs. 58–60, 1889. DALL, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 200.

Shell turbinated, thick; whorls five, convex to nearly flat; body-whorl subangular at base; ornamentation consists of seven to eight prominent nodose spiral ridges; suture distinct, sometimes quite deeply impressed; base flat, with ornamentation same as whorls, except less prominent; umbilicus deep, effuse, smooth; outer lip effuse, denticulated on lower portion.

*Dimensions.*—Alt. 17 mm.; lat. 18 mm.; defl. 80 degrees.

Some of the specimens show the mottled coloration of the live shell. Distinguishable by denticulation and ornamentation.

Rare in lower San Pedro series of Deadman Island and San Pedro; common in the upper San Pedro series of Los Cerritos and Crawfish George's; but rare in the upper San Pedro series of Deadman Island and San Pedro.

*Living.*—Catalina Island to San Diego (Cooper): Mazatlan (Carpenter).

*Pleistocene.*—San Pedro (Cooper; Arnold).

### Genus **Thalotia** *Gray.*

Shell ovate-turriculated, rather thick; not umbilicated; whorls flattened, with revolving ribs, which are sometimes granulated; aperture subrotund; columella tuberculated, truncate in front; outer lip rather thick, crenulated within.

*Thalotia conicus* Gray is a characteristic species.

### 378. **Thalotia caffea** *Gabb.*

*Turcica (Ptychstylis) caffea* GABB, Proc. Cal. Acad. Sci., Vol. III, 1865, p. 187; Pal. Cal., Vol. II, pp. 16, 84, Pl. III, fig. 27, 1869.
*Thalotia caffea* GABB, COOPER, Geog. Cat. West Coast Shells, p. 26, 1867. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 267.

Shell conical, thin; spire elevated, subacute; whorls five or six, flat; ornamentation consists of smooth keel on anterior part of whorl and row of nodes on posterior part next to suture; flat space between these two smooth; both keel and flat surface nodose on anterior part of body-whorl; suture very deep and narrow; body-whorl acutely angulated at base; base slightly convex, ornamented with several alternating large and small nodose spiral ridges; aperture trapezoidal; outer lip thin, bulging below; columella incrusted, and having two plications.

*Dimensions.*—Alt. 19 mm.; lat. 16 mm.; defl. 70 degrees.

Distinguishable from the *Calliostomæ* by the deep, narrow suture, large aperture, with bulging lower part of outer lip, and plicated columella.

Found in Pliocene of Deadman Island; one specimen from lower San Pedro series of Deadman Island.

*Living.*—Monterey (Cooper): San Pedro (Raymond).

*Pleistocene.*—Santa Barbara; San Pedro (Cooper): San Pedro (Arnold).

*Pliocene.*—San Pedro (Arnold).

### Genus **Phorcus** *Risso.*

Shell conoidal, umbilicated; umbilicus cylindrical or infundibuliform; whorls frequently tuberculated above and with channeled suture; columella sometimes terminating in a tubercular tooth.

*Phorcus magus* Linn. is a characteristic species.

### 379. **Phorcus pulligo** *Martyn.*

*Trochus pulligo* MART., Univ. Conch., Pl. LXXVI, 1784. PHILIPPI, Conch. Cab., p. 84, Pl. XV, fig. 3. FISCHER, Coq. Viv., p. 232, Pl. LXXX, fig. 1.

*Phorcus pulligo* MART., CPR., Brit. Assn. Rept., 1863, p. 653. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 259.

*Chlorostoma pulligo* MART., = *C. marcidus* GLD. (*fide* TRYON, Man. Conch., Vol. XI, p. 171, Pl. XXVI, figs. 23, 24, 25, 1889).

Shell broadly conical; whorls five, flat, but somewhat obsoletely ribbed or bluntly nodose in most specimens; surface shows extremely oblique lines of growth; suture distinct but not much impressed; base flat and smooth, except for faint incremental lines; aperture subovate; lips not thickened; umbilicus smooth, round and effuse.

*Dimensions.*—Alt. 18 mm.; lat. 22 mm.; defl. 78 degrees.

This shell is often confused with *Chlorostoma montereyi*, but may be distinguished from that species by its gradually expanding umbilicus, greater deflection, and lack of spiral sculpture. Specimens of this species were identified by Dr. Dall.

Rather common in the upper San Pedro series of Crawfish George's. The specimen figured is from the upper San Pedro series at Crawfish George's, and is now in the collection of Delos Arnold.

*Living.*—Sitka to San Pedro (Cooper.)

*Pleistocene.*—San Pedro; San Diego (Cooper): San Pedro (Arnold).

## Genus **Calliostoma** *Swainson.*

Shell trochiform, conical, not umbilicated; last whorl angulated and usually ribbed at the periphery; aperture quadrangular; columella simple, oblique, often ending in a tooth in front.

*Calliostoma zizyphinum* Linn. is a characteristic species.

### 380. Calliostoma annulatum *Martyn.*

*Trochus annulatus* MART., Univ. Conch., Vol. I, fig. 33, 1784. PHILIPPI, Conch. Cab., p. 11, Pl. III, figs. 3, 4.

*Zizyphinus annulatus* MART., A. ADS., Proc. Zool. Soc., 1851, p. 164. GRAY, Dieffenbach's N. Zealand, p. 237, No. 72.

*Calliostoma annulatum* MART., CPR., Brit. Assn. Rept., 1863, p. 652. GABB, Pal. Cal., Vol. II, p. 83, 1869. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 231. TRYON, Man. Conch., Vol. XI, p. 363, Pl. LXVII, fig. 43, 1889. KEEP, West Coast Shells, p. 79, fig. 64, 1892. WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, Pl. XXII, fig. 2.

Shell conical; whorls seven, slightly angulated in center, and ornamented with sharply nodose spiral ridges which increase by intercalation from two on third whorl to seven or eight on body-whorl; suture deep, distinct; body-whorl acutely angulated at base; base nearly flat, ornamented with numerous smooth, rounded spiral lines; aperture subquadrate; columella nearly straight, thickened.

*Dimensions.*—Alt. 17 mm.; lat. 16 mm.; defl. 67 degrees.

Distinguishable by slightly angulated whorls, nearly equally prominent nodose ridges, and nearly straight columella.

Quite rare in the upper San Pedro series of San Pedro.

*Living.*—Straits of Fuca to San Diego (Cooper).

*Pleistocene.*—San Pedro to San Diego (Cooper): San Pedro (Arnold).

*Pliocene.*—San Diego well (Dall).

### 381. Calliostoma canaliculatum *Martyn.*

*Trochus canaliculatus* MART., Univ. Conch., Vol. I, fig. 32, 1784.

*Zizyphinus canaliculatus* MART., GRAY, Dieffenbach's N. Zealand, p. 327. REEVE, Conch. Icon., fig. 18.

*Calliostoma canaliculatum* MART., CPR., Brit. Assn. Rept., 1863, p. 652. GABB, Pal. Cal., Vol. II, p. 83, 1869. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 231. TRYON, Man. Conch., Vol. X, Pl. XLI, fig. 34, 1888; Vol. XI, p. 361, Pl. LXVII, fig. 49, 1889. KEEP, West Coast Shells, p. 80, fig. 65, 1892. WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, Pl. XXII, fig. 6.

Shell conical; whorls six, flat, ornamented with very prominent rounded, spiral ridges, two on the third and fourth whorls, and then increasing by intercalation until the body-whorl in some specimens has five or six prominent ridges, with a less number of auxiliary riblets in between; suture deeply impressed, forming a canal; aperture subquadrate; base flat, and ornamented in the same way as the whorls; lip as in *C. costatum.*

*Dimensions.*—Long. 19 mm.; lat. 20 mm.; defl. 67 degrees.

Distinguishable by flat whorls, sutural canal, and few large spiral ridges.

Rare in the Pliocene of Deadman Island, and in the lower San Pedro series of Deadman Island and San Pedro; common in the upper San Pedro series of Deadman Island, San Pedro, Los Cerritos, and Crawfish George's. Found in the Pleistocene at Spanish Bight, and in the Pliocene at Pacific Beach, San Diego.

*Living.*—Straits of Fuca to San Diego (Cooper).

*Pleistocene.*—San Pedro to San Diego (Cooper): San Pedro; San Diego (Arnold).

*Pliocene.*—San Pedro; San Diego (Arnold).

### 382. Calliostoma costatum *Martyn.*

*Trochus costatus* MART., Univ. Conch., Pl. X, fig. 3, 1784. PHILIPPI, Conch. Cab., p. 275, Pl. XL, fig. 8.

*Calliostoma costatum* MART., CPR., Brit. Assn. Rept., 1863, p. 652. GABB, Pal. Cal., Vol. II, p. 83, 1869. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 231. TRYON, Man. Conch., Vol. XI, p. 362, Pl. XVI, figs. 6, 9; Pl. XVIII, fig. 16, 1889. KEEP, West Coast Shells, p. 81, fig. 66, 1892. WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, Pl. XXII, fig. 1.

*Zizyphinus filosus* WOOD, REEVE, Conch. Icon., fig. 27.

Shell turbinated, thick; whorls five, convex, and ornamented with about eight, almost equally prominent, spiral ridges; fine oblique incremental lines visible on most specimens; suture deeply impressed; base slightly convex, ornamented same as whorls; outer lip slightly effuse; columella thickened and incrusted.

*Dimensions.*—Alt. 22 mm.; lat. 20 mm.; defl. 70 degrees.

Distinguishable by the even convexity of the whorls, numerous, comparatively smooth, spiral ridges, and thickness of the shell, which is unusual for a member of this genus.

Rare in the lower San Pedro series of Deadman Island and San Pedro; and in the upper San Pedro series of Crawfish George's, Los Cerritos, and San Pedro. Found in the Pleistocene at Pacific Beach, San Diego.

*Living.*—Sitka to San Diego (Cooper).

*Pleistocene.*—San Pedro to San Diego (Cooper): San Pedro; San Diego (Arnold).

*Pliocene.*—San Fernando, Los Angeles County (Cooper).

### 383. Calliostoma gemmulatum *Carpenter.*

*Calliostoma gemmulatum* CPR., Brit. Assn. Rept., 1863, p. 653; Proc. Cal. Acad. Sci., Vol. III, 1864, p. 215. COOPER, 7th Ann. Rept. Cal. St. Min , 1888, p. 231. TRYON, Man. Conch., Vol. XI, p. 371, Pl. LXVII, fig. 54, 1889. KEEP, West Coast Shells, p. 81, 1892. WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, Pl. XXII, fig. 3.

Spire more acute than in other species of the genus; whorls six to seven, concave above, convex below; convex part has two or three rows of granular spiral ridges; concave surface ornamented with a few fine granular spiral ridges; suture indistinct; base flat, marked by several smooth spiral ridges; aperture circular.

*Dimensions.*—Alt. 18 mm.; lat. 15 mm.; defl. 46 degrees.

Found in upper San Pedro series of San Pedro, Los Cerritos, and Crawfish George's. Found in the Pliocene at Packard's Hill, Santa Barbara; and in the Pleistocene at Spanish Bight, San Diego.

*Living.*—San Pedro to San Diego (Cooper).

*Pleistocene.*—San Pedro to San Diego (Cooper): San Pedro; San Diego, (Arnold).

*Pliocene.*—Santa Barbara (Arnold).

### 384. Calliostoma tricolor *Gabb.*

*Calliostoma tricolor* GABB, Proc. Cal. Acad. Sci., Vol. III, 1865, p. 186; Pal. Cal., Vol. II, p. 17, Pl. III, fig. 28, 1869. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 231. TRYON, Man. Conch., Vol. XI, p. 370, Pl. LXVII, fig. 52, 1889. KEEP, West Coast Shells, p. 82, 1892. WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, Pl. XIX, fig. 8.

Shell conical; spire elevated, subacute; whorls five to six, flat to concave, with prominent, rounded keel on anterior margin; surface ornamented with fine spiral lines; suture impressed, distinct; base nearly flat, ornamented with fine spiral ridges and furrows; aperture subcircular; outer lip thin; columella slightly incrusted.

*Dimensions.*—Alt. 11 mm.; lat. 11 mm.; defl. 66 degrees.

Distinguishable by the prominent, smooth keel on the anterior part of whorls; and by the concavity and inconspicuous ornamentation of the upper part of the whorls.

Rare in the Pliocene at Deadman Island; in lower San Pedro series at San Pedro; and in upper San Pedro series of Crawfish George's, San Pedro, and Los Cerritos. Found in the Pleistocene at Spanish Bight, San Diego.

*Living.*—New Year Point to San Diego (Cooper): San Pedro (Arnold).

*Pleistocene.*—San Pedro to San Diego (Cooper): San Pedro; San Diego (Arnold).

*Pliocene.*—San Pedro (Arnold).

## Genus **Norrisia** *Bayle.*

Shell thick, conoidal, orbicular, covered by an epidermis, smooth; widely umbilicated, umbilicus surrounded by the callous extension of the columella; outer lip not thickened or sculptured within.

*Norrisia norrisii* Sby. is a characteristic species.

### 385. Norrisia norrisii *Sowerby.*

*Trochischus norrisii* SBY., Tank. Catalogue, 1825. CPR., Brit. Assn. Rept., 1863, p. 652. = *T. convexus* CPR. (*fide* GABB, Pal. Cal., Vol. II, p. 85, 1869). TRYON, Syst. and Struct. Conch., Vol. II, p. 315, Pl. LXXXI, fig. 64, 1883. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 268. KEEP, West Coast Shells, p. 86, fig. 72, 1892.

*Norrisia norrisii* SBY., DALL, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 200.

Shell of medium size, conoidal, orbicular, thick; spire only slightly elevated above bodywhorl; whorls three or four, only very slightly convex, smooth except for lines of growth; suture

only slightly appressed, distinct; aperture subtriangular; outer lip thin, slightly bowed anteriorly; umbilicus large, deep, surrounded by callous extension of the columella.

*Dimensions.*—Alt. 32 mm.; lat. 40 mm.

Described from a living specimen.

Found in upper San Pedro series at Deadman Island. Found also in the Pleistocene at Pacific Beach, San Diego.

*Living.*—Santa Barbara to San Diego (Cooper).

*Pleistocene.*—Santa Barbara (Cooper): San Pedro; San Diego (Arnold).

### Genus **Margarita** *Leach.*

Shell thin, globular-conical, umbilicated; whorls rounded, smooth; aperture rounded, pearly; lip sharp, smooth.

*Margarita helicina* Fabr. is a characteristic species.

### 386. **Margarita optabilis** *Carpenter*, var. **knechti**, var. nov.

PLATE V, FIG. 14.

*Gibbula optabilis* CPR., Brit. Assn. Rept., 1863, p. 653.

Shell small, conical, thin; turbinated apical whorls; whorls five; upper whorls rather angular, slightly tabulated above; body-whorl rounded, slightly angulated at base; two prominent spiral ridges, one at angle of whorl, the other near anterior margin; between these two ridges is a slightly concave surface sometimes ornamented with faint spiral ridges; oblique incremental lines quite prominent; suture impressed and distinct; base of body-whorl only slightly convex, and ornamented by five spiral ridges; umbilicus large, deep, effuse, smooth; aperture subrotund; inner lip incrusted and projecting slightly over umbilicus.

*Dimensions.*—Alt. 8.5 mm.; lat. 8 mm.; body-whorl 6.5 mm.; aperture 4.5 mm.; defl. 70 degrees.

Some of the specimens retain their mottled coloration. The sculpture varies much in this variety, the number of spiral ridges varying; and the ridges sometimes being nodose and sometimes smooth.

Specimens pronounced variety of *M. optabilis* by Dr. Dall.

Common in lower and rare in upper San Pedro series of San Pedro. The specimen figured is the type, which is from the lower San Pedro series at San Pedro, and is now in the United States National Museum.

*Pleistocene.*—San Pedro (Arnold).

### 387. **Margarita optabilis** *Carpenter*, var. **nodosa**, var. nov.

PLATE V, FIG. 13.

*Gibbula optabilis* CPR., Brit. Assn. Rept., 1863, p. 653.

Shell small, distinctly conical, thin; whorls five, flat, and ornamented by two prominent slightly nodose spiral ridges, each about one-fourth width of whorl from margin; between these two

ribs, and also near the posterior margin of whorl, are less prominent ridges; incremental lines visible; body-whorl angular, with nodose ridge on angle; base of this whorl nearly flat, and ornamented with two prominent nodose spiral ridges and several lesser ones; umbilicus deep, but not very effuse; aperture ovate; inner lip slightly overlapping umbilicus; suture not impressed, indistinct.

*Dimensions.*—Alt. 6.5 mm.; lat. 6.5 mm.; body-whorl 5 mm.; aperture 3.5 mm.; defl. 75 degrees.

This variety is distinguishable by its simple conical shape, flat whorls, and nodose ridges. It may grade into the turbinated, convex-whorled variety, *M. knechti*, although no mutations have been found in the large series at hand. This form was pronounced a variety of *M. optabilis* by Dr. Dall.

Found in the lower San Pedro series of San Pedro and Deadman Island. The specimen figured is the type, which is from the lower San Pedro series at San Pedro, and is now in the United States National Museum.

*Pleistocene.*—San Pedro (Arnold).

### 388. Margarita parcipicta *Carpenter*, var. pedroana, var. nov.

PLATE V, FIG. 16.

*Gibbula parcipicta* CPR., Brit. Assn. Rept., 1863, p. 653; Ann. & Mag. Nat. Hist., 3rd Ser., Vol. XIV, 1864, p. 427.

Shell small, thin, globular, conical; spire elevated, subacute; whorls four, rounded, tabulated near posterior margin; four spiral ridges on upper whorls; suture deeply impressed and distinct; base of body-whorl rounded, and ornamented by fine spiral ridges; umbilicus deep and effuse; aperture subcircular.

*Dimensions.*—Alt. 5.5 mm.; lat. 5.5 mm.; body-whorl 4.5 mm.; aperture 3 mm.; defl. 80 degrees.

Specimens pronounced variety of *M. parcipicta* by Dr. Dall.

Found in the lower San Pedro series at Deadman Island and San Pedro; and in the upper San Pedro series at Deadman Island, San Pedro, and Los Cerritos. The specimen figured is the type, which is from the lower San Pedro series at San Pedro, and is now in the United States National Museum.

*Pleistocene.*—San Pedro (Arnold).

### 389. Margarita pupilla *Gould.*

PLATE X, FIG. 15.

*Trochus pupillus* GLD., Proc. Bost. Soc. Nat. Hist., Vol. III, 1850, p. 91; Wilkes' Expl. Exped., Vol. XII, p. 186, fig. 208, 1852.

*Margarita pupilla* GLD., = *M. calostoma* A. ADS. (*fide* CPR., Brit. Assn. Rept., 1863, p. 653). = *M. salmonea* CPR. (*fide* COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 249). TRYON, Man. Conch., Vol. XI, p. 295, Pl. XLIV, figs. 29–32, 1889. KEEP, West Coast Shells, p. 78, fig. 63, 1892. WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 202.

Shell small, ovate-conic, rather solid; whorls five, convex, flattened slightly above, forming a narrow, tabulate band just below suture; body-whorl obtusely angulated; surface sculptured with

small, flattened, subequal, equidistant, revolving ribs, five on the upper whorls; interspaces ornamented by fine, oblique, incremental lines; base of body-whorl nearly flat, and ornamented with numerous fine, revolving lines, which become coarser near umbilicus; suture deeply impressed, distinct; aperture circular; columella somewhat arcuate; umbilicus small, groove-like; outer lip sharp, nacreous layer on inner lip.

*Dimensions.*—Alt. 5.8 mm.; lat. 8 mm.; defl. 67 degrees.

Somewhat resembles *Solariella peramabilis*, but may be distinguished by smaller umbilicus; flatter, finer sculptured base; whorls less flattened above and finer sculptured, both spiral and transverse. Dr. Dall pronounced the Pliocene specimen a variety of *M. pupilla*.

Found in Pliocene at Deadman Island; two specimens, one of which is figured, and is now in the collection of Delos Arnold. Found also in the Pleistocene at the bath-house, Santa Barbara.

*Living.*—Alaska to Catalina Island, rare at latter place (Cooper).

*Pleistocene.*—Santa Barbara (Cooper; Arnold).

*Pliocene.*—San Pedro (Arnold).

### Genus **Solariella** *S. Wood.*

Shell thin, globular-conical; generally with wide crenated umbilicus; whorls rounded, sculptured; aperture rounded; lip sharp, smooth.

*Solariella peramabilis* Cpr. is a characteristic species.

### 390. Solariella cidaris *A. Adams.*

PLATE VII, FIG. 11.

*Margarita cidaris* A. AD., CPR., Brit. Assn. Rept., 1863, p. 653. CPR., Ann. Mag. Nat. Hist., 3rd Ser., Vol. XIV, 1864, p. 426; Vol. XV, 1865, p. 29. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 249 (young); = *Solariella oxybasis* DALL (*fide* COOPER, Bull. No. 4, Cal. St. Min. Bureau, Part 3, 1894, p. 27).

*Turcicula cidaris* (A. AD.) CPR., TRYON, Man. Conch., Vol. XI, p. 331, 1889.

*Solariella cidaris* A. AD., WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 202, Pl. XXII, fig. 4.

Shell conical; spire elevated, subacute; whorls six to seven; four upper whorls only slightly convex; lower whorls very convex; surface ornamented with spiral rows of nodes which grade into nodose ribs on the lower side of the body-whorl; suture deeply impressed; aperture circular; outer lip thin; inner lip and columella enameled, the incrustation completely obscuring the small umbilicus in most specimens.

*Dimensions.*—Alt. 40 mm.; lat. 33 mm.; body-whorl 26.5 mm.; aperture 13 mm.; defl. 66 degrees.

The specimen described and figured is an exceptionally large one, the average altitude being only 18 mm. Identification by Dr. Dall.

Rare in the Pliocene; only about a dozen specimens found, and all of these from the Pliocene of Deadman Island. According to Dr. Cooper, San Marcial is on

the peninsula of Lower California, and is in the Tertiary belt. This would correspond to the horizon of the formation at Deadman Island, where they are found only in the Pliocene. The specimen figured is from the Pliocene of Deadman Island, and is now in the collection of Delos Arnold.

*Living.*—Neeah Bay to Catalina Island (dredged) (Cooper).

*Pleistocene.*—San Marcial (Carpenter).

*Pliocene.*—San Pedro (Arnold; Williamson).

### 391. Solariella peramabilis *Carpenter.*

PLATE VII, FIG. 2.

*Solariella peramabilis* CPR., Brit. Assn. Rept., 1863, p. 653. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 265. TRYON, Man. Conch., Vol. XI, p. 312, Pl. LXVII, figs. 59–61, 1889. WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 202.

Shell small, conical; spire elevated, subacute; whorls five, convex, with narrow tabulate band just anterior to suture, and ornamentation of five or six spiral ribs crossed by fine lirulæ; suture deeply impressed; aperture circular; umbilicus open, large, with three internal spiral lines.

*Dimensions.*—Alt. 14.5 mm.; lat. 12 mm.; body-whorl 10.2 mm.; aperture 5 mm.; defl. 82 degrees.

The specimen described was identified by Dr. Dall.

Rare in the Pliocene; four specimens found in the Pliocene of Deadman Island. The specimen figured is from the Pliocene of Deadman Island, and is now in the collection of Delos Arnold.

*Living.*—Catalina Island (30 fathoms) (Williamson).

*Pliocene.*—San Pedro (Arnold).

## Family LXXXV. CYCLOSTREMATIDÆ.

### Genus **Vitrinella** *C. B. Adams.*

Shell minute, depressed turbiniform; widely umbilicated; aperture large, rounded.

*Vitrinella anomala* d'Orb. is a characteristic species.

### 392. Vitrinella williamsoni *Dall.*

*Vitrinella williamsoni* DALL, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 202, Pl. XXI, figs. 2 and 3.

"Shell small, white, depressed, with two and a half whorls; spire flattened; suture appressed, with a shallow channel or excavation outside of the appressed margin of the whorl, outside of which the convexity of the whorl rises higher than the suture; base slightly more rounded than the upper side, with a wide and flaring umbilicus; periphery rounded; aperture rounded, oblique; surface polished, finely striated here and there by the incremental lines, which are most prominent above.

"*Dimensions.*—Maximum diameter of shell, 5.5 mm.; minimum diameter, 4.5 mm.; altitude, 1.25 mm."

Several specimens of this species were found in the lower San Pedro series of San Pedro. They were in a perfect state of preservation, and if they had been found on the beach would, no doubt, have been called "dead shells." It is possible that some of the shells reported as "dead on beach" have been washed down from the fossil beds, and have been listed as living.

Found in the upper San Pedro series of San Pedro, and the lower San Pedro series of Deadman Island; rare.

*Living.*—San Pedro (Williamson).

*Pleistocene.*—San Pedro (Arnold).

## Superfamily ZYGOBRANCHIA.

## Family LXXXVI. HALIOTIDÆ.

### Genus **Haliotis** *Linné.*

Shell ear-shaped, with a small flat spire; aperture very wide, iridescent; exterior striated, dull; outer angle perforated by a series of holes, those of the spire progressively closed.

*Haliotis gigantea* Chemn. is a characteristic species.

### 393. **Haliotis fulgens** *Philippi.*

*Haliotis fulgens* PHIL., Zeitschr. f. Mal., p. 150, 1845; Abbild. und Beschreib., p. 11, Pls. VII and VIII, fig. 1, 1847. CPR., Brit. Assn. Rept., 1863, p. 574. TRYON, Man. Conch., Vol. XII, p. 81, Pl. XII, figs. 61, 62, 1890. WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 198.

*Haliotis splendens* RVE., Icon. Conch., Pl. III, fig. 9. KEEP, West Coast Shells, p. 90, fig. 76, 1892. WEINKAUFF, Conch. Cab., p. 24, Pls. VII and VIII.

Shell large, flat, oval; spire very slightly raised near margin of shell; surface spirally grooved, the grooves appearing as ridges on the interior; holes four to seven, elevated margins; interior highly colored; outer layer of shell brownish red.

*Dimensions.*—Long. 112 mm.; lat. 88 mm.; depth 21 mm.

Distinguished from *H. rufescens* and *H. cracheroidii* by grooved surface and colors of interior.

This specimen, which was found in the conglomerate of the upper San Pedro series of Deadman Island, is probably the first authentic record of an *Haliotis* from the Pleistocene of California. It was a perfect specimen when found, but in removing it from the matrix it was unfortunately broken into several fragments. A small but perfect specimen of this species was found in the Pleistocene (upper San Pedro series) at Spanish Bight, San Diego.

Dr. Cooper has reported *H. cracheroidii* and *H. rufescens* from the Pleistocene of San Pedro, but upon examination of the fossils (?) upon which he based his report, which are now in the State Museum Collection at the University of California, they

were found to be recent shells from the kitchen-middens that overlie all of the San Pedro fossil deposits. The mistake of reporting kitchen-midden shells as "Pleistocene" and "Pliocene" has been made by a number of collectors, who have mistaken these accumulations for fossil deposits. The two species of *Haliotis* above referred to, besides *H. fulgens*, are common in many of the kitchen-middens along the coast, and especially so in those around San Pedro.

*Living.*—Monterey to Lower California (Carpenter).

*Pleistocene.*—San Pedro; San Diego (Arnold).

## Family LXXXVII. FISSURELLIDÆ.

### Subfamily *FISSURELLIDEINÆ.*

### Genus **Lucapina** *Gray.*

Shell oval-oblong, conic, depressed, cancellated; summit subcentral, the oval opening surrounded by a callus; margin crenulated.

*Lucapina crenulata* Sby. is a characteristic species.

#### 394. **Lucapina crenulata** *Sowerby.*

*Fissurella crenulata* SBY., Tank. Catalogue, App., p. vi, 1825; Conch. Ill., No. 19, figs. 31, 38, 1831. *Lucapina crenulata* SBY., CPR., Proc. Zool. Soc., 1856, p. 223. CPR., Brit. Assn. Rept., 1863, p. 651. GABB, Pal. Cal. Vol. II, p. 85, 1869. TRYON, Struct. and Syst. Conch., Vol. II, p. 326, Pl. LXXXIII, fig. 17, 1883. TRYON, Man. Conch., Vol. XII, Pl. XLIV, figs. 95, 96, 1890. KEEP, West Coast Shells, p. 95, fig. 79, 1892. WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 198.

Shell large, oval, conical, depressed; surface cancellated with numerous radiating ridges and concentric incremental lines; summit subcentral, the oval opening surrounded by a callus; margin crenulated.

*Dimensions.*—Long. 90 mm.; lat. 57 mm.; alt. 20 mm.

This species is distinguishable by its large size and rather faint sculpture. Rare in the upper San Pedro series at Los Cerritos.

*Living.*—San Pedro to San Diego (Carpenter; Williamson).

*Pleistocene.*—San Pedro (Arnold).

### Subfamily *EMARGINULINÆ.*

### Genus **Fissuridea** *Swainson.*

Shell oval, conical, depressed, with the apex in front of the center, and perforated by oblong opening; surface radiated or cancellated; margin crenulated; callosity often truncate, sometimes aminated.

*Fissuridea inæqualis* Sby. is a characteristic species.

### 395. Fissuridea aspera *Eschscholtz.*

*Fissurella aspera* ESCH., Zool. Atlas, Vol. V, p. 21, Pl. XXIII, fig. 5, 1833.
*Glyphis aspera* ESCH., CPR., Proc. Zool. Soc., 1856, p. 223. CPR., Brit. Assn. Rept., 1863, p. 651. GABB, Pal. Cal., Vol. II, p. 85, 1869. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 241. KEEP, West Coast Shells, p. 96, fig. 80, 1892.
*Fissuridea aspera* ESCH., WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 197.

Shell oblong, conical; anterior and posterior slopes only very slightly convex; apical hole anterior to center, nearly circular, the plane of its outer rim sloping considerably forward; numerous prominent, straight, rough ribs radiate from the apical hole and produce a corrugated margin for the shell; inner side of rim corrugated and slightly effuse; inner surface smooth.

*Dimensions.*—Long. 60 mm.; lat. 42 mm.; alt. 23 mm.

Easily distinguishable by its large size and prominent, rough, radiating ridges and alternating color bands. Has fewer and rougher ribs than *F. murina*, and a more elliptical apical hole.

Not uncommon in the lower San Pedro series at Deadman Island and San Pedro; common in the upper San Pedro series at Crawfish George's, and rare in the same formation at Los Cerritos, Deadman Island, and San Pedro.

*Living.*—Sitka to San Pedro (Cooper).

*Pleistocene.*—Santa Barbara to San Pedro (Cooper): San Pedro (Arnold).

### 396. Fissuridea inæqualis *Sowerby.*

*Fissurella inæqualis* SBY., Proc. Zool. Soc., 1834, p. 126; Conch. Ill., fig. 45. REEVE, Conch. Icon., fig. 50.
*Glyphis inæqualis* SBY., CPR., Brit. Assn. Rept., 1856, p. 184, Pl. VII, figs. 4 *a*–4 *n*. TRYON, Man. Conch., Vol. XII, p. 215, Pl. XXXIV, figs. 63, 64, 1890.
*Fissurella pica* SBY., Proc. Zool. Soc., 1834, p. 126; Conch. Ill., Vol. II, figs. 32, 33. REEVE, Conch. Icon., fig. 49.
*Fissurella inæqualis* var. *pica* SBY., CPR., Brit. Assn. Rept., 1856, p. 184. TRYON, Man. Conch., Vol. XII, p. 215, Pl. XXXIV, fig. 64, 1890.

Shell oblong, conical, much depressed; anterior and posterior surfaces convex; lateral view of margin a line convex upward (as if shell had been on a convex surface); radiating ridges numerous and fine; concentric ridges numerous and nearly as prominent as the radiating ridges; the two systems of lines giving the surface a decidedly cancellate appearance; apical hole slightly oblong, anterior to center; inner surface smooth; inner surface of margin finely corrugated; color white.

*Dimensions.*—Long. 22.5 mm.; lat. 12 mm.; alt. 6 mm.

Distinguishable from other members of this genus occurring in this formation by its small size and the convex appearance of the sloping sides. The specimen described was identified by Dr. Dall.

Six specimens in the upper San Pedro series of San Pedro; also found in the same horizon at Los Cerritos, Deadman Island, and Long Beach.

*Living.*—Guacomayo; Galapagos Islands (Carpenter).

*Pleistocene.*—San Pedro (Arnold).

### 397. Fissuridea murina (*Carpenter*) *Dall.*

*Glyphis densiclathrata* var. *murina* CPR., mss.
*Fissuridæ murina* (CPR.) DALL, Proc. U. S. Nat. Mus., Vol. VIII, 1885, p. 543; Vol. XV, 1892, p. 197.
*Glyphis densiclathrata* RVE., TRYON, Man. Conch., Vol. XII, p. 215, Pl. XXXIX, fig. 81, 1890 (pars). COOPER, Bull. No. 4, Cal. St. Min. Bureau, Part 3, 1894, p. 27.

Shell resembles *F. aspera* in general outline; apical hole nearly central, circular; radiating ridges numerous and smooth, except for fine incremental lines; inner margin of shell quite evenly crenulated; color white.

*Dimensions.*—Long. 46 mm.; lat. 30 mm.; alt. 16 mm.

Distinguishable from *F. aspera* by lack of coloration, finer and more numerous ribs, more central and more nearly round apical hole. Smaller than the latter. Dr. Dall says that this is the same species which Californian conchologists have been calling *Glyphis densiclathrata*, but that it is not the same as Reeve's *G. densiclathrata*.

Four specimens in the upper San Pedro series of San Pedro; found in the same horizon at Deadman Island, Los Cerritos, and Crawfish George's; and in the lower San Pedro series at Deadman Island.

*Living.*—San Pedro; Catalina (Williamson): Santa Barbara (Cooper).

*Pleistocene.*—San Pedro (Arnold): San Joaquin Bay, Orange County (Bowers).

### Genus **Clypidella** *Swainson.*

Shell oval, rugose, slightly elevated, truncated at the anterior extremity; perforation large, subcentral, or somewhat anterior.

*Clypidella pustulata* Lam. is a characteristic species.

### 398. Clypidella bimaculata *Dall.*

*Clypidella (?) bimaculata* DALL, mss., in COOPER, Geol. Cat. W. C. Shells, No. 470, 1866.
*Fissurellidæa bimaculata* DALL, Am. Jour. Conch., Vol. VII, 1872, p. 132, Pl. XV, fig. VII. KEEP, West Coast Shells, p. 97, fig. 82, 1892.
*Clypidella bimaculata* DALL, GABB, Pal. Cal., Vol. II, pp. 86, 124, 1869. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 235.
*Megatebennus bimaculatus* DALL, TRYON, Man. Conch., Vol. XII, p. 183, Pl. XLIV, fig. 94, 1890. WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 198.

Shell resembles *C. callomarginata.* Aperture and apical hole elliptical, the latter being central; wide, thickened ridge on inner side of rim and on inner side of apical hole. Smaller than *C. callomarginata.*

Specimens identified by Dr. Dall.

Not uncommon in the lower San Pedro series of Deadman Island and San Pedro; rare in the upper San Pedro series of Los Cerritos and San Pedro.

*Living.*—Farallon Islands to Santa Barbara Islands (Cooper).

*Pleistocene.*—Santa Barbara; San Pedro (Cooper): San Pedro (Arnold).

### 399. Clypidella callomarginata *Carpenter.*

"*Clypidella callomarginata* CPR., Brit. Assn. Rept., 1866." GABB, Pal. Cal., Vol. II, pp. 86, 124, 1869. DALL, Am. Jour. Conch., Vol. VII, 1872, p. 133, Pl. XV, fig. 8. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 235. TRYON, Man. Conch., Vol. XII, p. 197, Pl. XLIV, figs. 3, 4, 5; Pl. LXI, figs. 1–5, 1890.

*Fissurellidæa callomarginata* CPR., KEEP, West Coast Shells, p. 97, 1892.

*Lucapinella callomarginata* CPR., WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 198.

Shell elongate-ovate, conical, depressed; apical hole elongate-ovate, large, not central; surface sculptured by alternating large and small radiating ridges, and prominent, concentric raised lines; aperture elongate-ovate; margin crenulated, thickened.

*Dimensions.*—Long. 22 mm.; lat. 12 mm.; alt. 4.5 mm.

The specimen described was identified by Dr. Dall.

Rare in the lower San Pedro series of Deadman Island and San Pedro; and in the upper San Pedro series of Crawfish George's, Los Cerritos, and San Pedro.

*Living.*—Lobitos to San Diego (Cooper).

*Pleistocene.*—San Pedro to San Diego (Cooper): San Pedro (Arnold).

## Genus **Fissurella** *Bruguière.*

Shell oval, conical, depressed, with the apex in front of the center, and perforated; surface radiated or cancellated.

*Fissurella picta* Gmel. is a characteristic species.

### 400. Fissurella volcano *Reeve.*

*Fissurella volcano* RVE., Icon. Conch., Pl. IV, fig. 2, 1849. SBY., Thes. Conch., Vol. III, p. 192, fig. 87. CPR., Brit. Assn. Rept., 1863, p. 651. GABB, Pal. Cal., Vol. II, p. 86, 1869. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 240. TRYON, Man. Conch., Vol. XII, p. 156, Pl. LXII, figs. 16–18, 1890. KEEP, West Coast Shells, p. 96, fig. 81, 1892. WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 197.

Shell oblong, conical, apical hole oblong, slightly anterior to center; numerous small radiating ribs run down to the margin; margin smooth; alternating red and dark colored stripes radiate from the apical hole; sloping surface straight.

*Dimensions.*—Long. 27 mm.; lat. 19 mm.; alt. 10 mm.

Distinguishable by the coloration, which is apparent in all the Pleistocene specimens that have been examined. Much smaller than *F. aspera* Esch., which is the only Pleistocene limpet it resembles.

Rather common in the lower San Pedro series at Deadman Island and San Pedro; and in the upper San Pedro series at Deadman Island, Los Cerritos, Crawfish George's, and San Pedro. Found in the Pleistocene at Pacific Beach, San Diego.

*Living.*—Santa Cruz to San Diego (Cooper).

*Pleistocene.*—Santa Barbara to San Diego (Cooper): San Pedro; San Diego (Arnold).

### Genus **Puncturella** *Lowe.*

Shell conical, elevated, with the apex recurved; perforation in front of the apex, with a raised border (septum) internally; surface cancellated.

*Puncturella noachina* Linn. is a characteristic species.

### 401. **Puncturella cucullata** *Gould.*

*Rimula cucullata* GLD., Proc. Bost. Soc. Nat. Hist., Vol. II, 1846, p. 159; Wilkes' Expl. Exped., Vol. XII, p. 268, fig. 475, 1852.

*Puncturella cucullata* GLD., CPR., Brit. Assn. Rept., 1863, p. 651. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 261. TRYON, Man. Conch., Vol. XII, p. 232, Pl. XLII, figs. 72-75; Pl. LXIII, figs. 38, 39, 1890.

Shell shaped like an oblique cone, with an elevated acute apex posterior to the center and curving forward like a curved beak; sixteen to eighteen prominent radiating ribs with three to five less prominent ribs between each of the larger; ribs muricated by fine incremental lines; fissure narrow and narrowing upwards; aperture ovate; inner edge crenulated, furrows following the external ridges only for short distance from ribs.

*Dimensions.*—Long. 22 mm.; lat. 15.5 mm.; alt. 13.5 mm.

The specimen described was identified by Dr. Dall.

Rare in lower San Pedro series of San Pedro; four specimens; also found in Pliocene of Deadman Island; and upper San Pedro series at San Pedro. Found in the Pliocene at Packard's Hill, Santa Barbara.

*Living.*—Straits of Fuca to Monterey (Cooper).

*Pleistocene.*—Santa Barbara (Cooper): San Pedro (Arnold).

*Pliocene.*—Packard's Hill, Santa Barbara (Arnold).

### 402. **Puncturella galeata** *Gould.*

*Rimula galeata* GLD., Proc. Bost. U. S. Nat. Hist., Vol. II, 1846, p. 159; Wilkes' Expl. Exped., Vol. XII, p. 369, fig. 476, 1852.

*Puncturella galeata* GLD., CPR., Brit. Assn. Rept., 1863, p. 651. TRYON, Man. Conch., Vol. XII, p. 230, Pl. XLII, figs. 62–65, 1890.

Shell erect, conical; apex central, elevated, acute, with the point hooked forward; numerous, nearly equal, sharp raised lines radiate from the apex; incremental lines fine and numerous; fissure narrow and small; in front of sulcus, near the summit, is a transverse rib having between it and the formix on each side a little triangular pit.

*Dimensions.*—Long. 8.1 mm.; lat. 5.5 mm.; alt. 6 mm.

The specimen described was identified by Dr. Dall.

One specimen in lower San Pedro series of San Pedro; also found in Pliocene of Deadman Island.

*Living.*—Puget Sound district (Carpenter).

*Pleistocene.*—San Pedro (Arnold).

# Subclass ISOPLEURA.

## Order POLYPLACOPHORA.

## Superfamily EOCHITONIA.

### Family LXXXVIII. CHITONIDÆ.

#### Genus **Ischnochiton** *Gray.*

Shell thin; laminæ of insertion regular, acute, neither pectinate nor serrate; eaves large; sinus usually smooth; girdle squamose, the squamæ generally striate.

*Ischnochiton longicymoa* Blainv. is a characteristic species.

#### 403. **Ischnochiton regularis** *Carpenter.*

*Chiton regularis* CPR., Proc. Zool. Soc., 1855, p. 232.
*Ischnochiton regularis* CPR., KEEP, West Coast Shells, p. 107, fig. 93, 1892. TRYON, Man. Conch., Vol. XIV, p. 142, Pl. XVIII, figs. 41, 46, 1892.

Shell depressed, elongate-oval, width half of length; valves not sharply arched; lateral areas ornamented with concentric, slightly granular ridges and fine radiating lines; central area with inconspicuous fine irregular lines; apex smooth; mucro longitudinally ridged with irregular raised lines.

Description partly from living shell. The only fossil representative of this species so far reported is a perfect central valve found in the upper San Pedro series of San Pedro in 1894 by Dr. G. H. Ashley.

*Living.*—Monterey (Carpenter): West Coast (Keep).

*Pleistocene.*—San Pedro (Ashley).

#### Genus **Cryptochiton** *Midd. & Gray.*

Shell large; valve entirely immersed in the girdle, which is minutely fasciculately pilose.

Type, *Cryptochiton stelleri* Midd.

#### 404. **Cryptochiton stelleri** *Middendorff.*

*Chiton stelleri* MIDD., Bull. Acad. St. Peters., Vol. VI, 1846, p. 116.
*Chiton (Cryptochiton) stelleri* MIDD., Mal. Ross., Pt. 1, p. 93, Pl. I, figs. 1, 2, 1847.
*Chiton amiculatus* SBY., Thes. Conch., III, *Chitons*, fig. 80.
*Chiton sitkensis* RVE., Icon. Conch., Pl. X, sp. 55.
*Cryptochiton stelleri* MIDD., CPR., Brit. Assn. Rept., 1863, p. 648. GABB, Pal. Cal., Vol. II, p. 87, 1869. TRYON, Struct. and Syst. Conch., Vol. II, p. 346, Pl. LXXXV, fig. 83, 1883. COOPER, 7th Ann. Rept. Cal. St. Min., 1888, p. 237. KEEP, West Coast Shells, p. 111, fig. 99, 1892. TRYON, Man. Conch., Vol. XV, p. 148, Pl. VII, figs. 7–13; Pl. VI, fig. 6, 1893.
*Chiton californicus* PRESCOTT, Am. Jour. Sci., 2nd Ser., Vol. XXXVIII, 1864, p. 185.

One valve was found in the lower San Pedro series of Deadman Island, and two in the Pliocene of the same locality. One is probably an end valve and is distinguishable by its strong convexity, thickness, and smooth surface. It has a small, acute notch on each side near the end.

*Dimensions.*—Long. 20 mm.; lat. 30 mm.; alt. 13 mm.

*Living.*—Straits of Fuca to Monterey; Kamtschatka (Cooper): Hakodate, Japan (?) (Carpenter).

*Pleistocene.*—San Diego (Cooper): San Pedro (Arnold).

*Pliocene.*—Deadman Island, San Pedro (Arnold).

## Superfamily OPSICHITONIA.

## Family LXXXIX. MOPALIIDÆ.

### Genus **Mopalia** *Gray.*

Shell regular; laminæ lengthened; anterior valve with six or more slits, the others with a single slit; last valve sinulate behind; sinus narrow, mucro median, depressed; sutures indented; girdle wide, bristly, sometimes fissured behind, sometimes projecting anteriorly.

*Mopalia blainvillei* Brod. is a characteristic species.

### 405. **Mopalia ciliata** *Sowerby.*

*Chiton muscosus* GLD., Proc. Bost. Soc. Nat. Hist., Vol. II, 1846, p. 145; Wilkes' Expl. Exped., Vol. XII, p. 313, fig. 436, 1852.
*Mopalia muscosa* GLD., CPR., Brit. Assn. Rept., 1863, p. 648.
*Mopalia ciliata* SBY., KEEP, West Coast Shells, p. 110, fig. 98, 1892. WILLIAMSON, Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 196.

Shell depressed, rather broad, oval; obliquely ridged along the back; sculpture prominent and covering whole of surface; side areas sculptured with granulated, radiating ridges; central area ornamented with longitudinal, granulated, raised lines; mucro median depressed, ornamented with sharp, oblique lines which meet on middle and form an acute angle open anteriorly; anterior valve large, semicircular, with ten granulated, elevated, radiating lines, and interspaces granulated as in lateral areas.

*Dimensions.*—Long. 40 mm.; lat. 19 mm.; depth 6 mm.

Description from living specimen. The only specimen of this species ever reported in the fossil state was found in the upper San Pedro series of San Pedro. It is a perfect anterior valve, 10 millimeters wide and 5.2 millimeters long.

*Living.*—Vancouver to Monterey (Carpenter): San Pedro (Williamson).

*Pleistocene.*—San Pedro (Arnold).

# ARTHROPODA.

## Class CRUSTACEA.[1]

## Subclass EUCRUSTACEA.

### Superorder CIRRIPEDIA.

### Order THORACICA.

#### Family XC. BALANIDÆ.

Genus **Balanus** *Lister.*

Shell low, conical or cylindrical, composed of six pieces. Opercular plates subtriangular; base membranous or calcareous.

**406. Balanus concavus** *Bronn.*

*Balanus concavus* BRONN, Italiens Tertiar-Gebilde (1831) et Lethæa Geognostica, *b*, II, 3, 1155 (1838), Tab. XXXVI, fig. 12; = *B. cylindraceus* var. *concavus* LAM.; = *Lepas tintinnabulum* BROCCHI, (*fide* DARWIN, Monog. Cerripedia, II, p. 235, Pl. IV, fig. 4*a*–4*e*, 1854).

Shell longitudinally striped with white and pink, or dull purple, sometimes wholly white; scutum finely striated longitudinally; internally, adductor ridge very or moderately prominent.

This is the common pink barnacle of the west coast. Darwin reports this species as fossil from Coralline crag, England; subappenine formations, near Turin, Asti, Colle in Tuscany; Tertiary beds near Lisbon; Tertiary beds, Williamsburg and Evergreen, Virginia; Maryland.

Sometimes found in the upper San Pedro series of San Pedro, Los Cerritos, Crawfish George's, and Deadman Island; also reported from the lower San Pedro series of San Pedro. Found in the Pliocene at Packard's Hill, Santa Barbara; and at Russ School, San Diego; in the Pleistocene at Barlow's ranch, Ventura; and at Spanish Bight and Pacific Beach, San Diego.

*Living.*—Panama; Peru; San Pedro, California; Philippine Archipelago; Australia (Darwin).

*Pleistocene.*—San Pedro (Arnold).

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[1] The classification and generic descriptions of this class, unless otherwise stated, are from Eastman's Zittel's "Text-Book of Paleontology."

# Superorder MALACOSTRACA.[1]

## Order DECAPODA.

## Suborder BRACHYURA.

### Subtribe CANCROIDEA.

#### Section *Cancrini.*

#### Genus **Cancer** *Linné.*

Carapace transverse, subelliptical, indistinctly areolated; antero-lateral margins regularly arcuated and armed with ten teeth; front narrow, cut into five teeth or lobes; eye-peduncles short, orbits small, with two fissures in both upper and lower margins; antennules longitudinal, or nearly so; basal antennal joint somewhat enlarged and united with the front, thus excluding the short flagellum from the orbit; merus of the maxillipeds distally truncated, and not produced at the antero-external angle; chelipeds subequal, the hand generally costate on the outer surface.

#### 407. **Cancer breweri** *Gabb.*

*Cancer breweri* GABB, Pal. Cal., Vol. II, p. 1, Pl. I, fig. 1, 1869. COOPER, 7th Annual Rept. Cal. St. Min., 1888, p. 227.

"Hand shorter, more robust, and broader proportionally than that of *C. magister* Dana; upper margin flattened and bordered by two well-defined ridges, each bearing about four tubercles; outer surface marked by five nearly obsolete ridges minutely tuberculated; fingers shorter than in *C. magister*, the movable one more curved, and both with the denticles nearly obsolete" (Gabb).

*Dimensions.*—Length of hand 82 mm.

The above description is a copy of Gabb's original. A well preserved hand from the lower San Pedro series of Deadman Island corresponds almost exactly with Gabb's figure of his type. *C. magister* is the common large edible crab of the California coast.

*Pleistocene.*—San Pedro (Arnold).

*Pliocene.*—Calleguas ranch, Ventura County (Brewer).

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[1] Divisione of this suborder and generic description from "Synopsis of California Stalk-Eyed Crustacea." By S. J. Holmes. Occasional Papers, Cal. Acad. Sci., No. VII, p. 47, 1900.

# VERTEBRATA.

## Class PISCES.

### Order ELASMOBRANCHII.

### Suborder SELACHII.

### Family TRYGONIDÆ.

#### Genus **Urolophus**.

**408. Urolophus halleri** (?) *Cooper*.

Two stings of this species (one of the common Sting-Rays of the California coast) were found in a perfect state of preservation in the upper San Pedro series at San Pedro. Dr. C. H. Gilbert, who identified the specimens, said that owing to the insufficiency of the evidence offered by the sting alone he was unable to make a definite specific determination.

*Pleistocene.*—San Pedro (Arnold).

# PART III. BIBLIOGRAPHY.

The following Bibliography is intended to give all of the articles which refer either to the geology or paleontology mentioned in this paper. Inasmuch as nearly all of the species found as fossils in the deposits at San Pedro are living at the present time, most of the articles refer to living shells. Dr. Stearns has kindly prepared a complete list of his publications up to January 1, 1901, and as a complete bibliography of his writings has never been published it will be included here under his name.

Many of the references given were taken from the Bibliography of Fossil Mollusca, prepared by the late Dr. James G. Cooper, and published in Bulletin No. 4 of the California State Mining Bureau.


1852. ADAMS, CHAS. B. Catalogue of Panama Shells. *Ann. N. Y. Lyc. Nat. Hist.*, Vol. V, 1852; also separately.

Full notes and descriptions; no figures. Out of nearly 500 species, over 100 were new; but very few of them extend to California, though many of the species are found living or fossil farther north.

1835. ADAMS, HENRY AND ARTHUR. Various articles published in *Proc. Zool. Soc.*, 1835 to 1876.

1853–83. ———The Genera of Recent Mollusca. 2 vols., 8vo, and 138 plates. London, 1853–83.

This fine systematic work contains figures and descriptions of several West Coast mollusca.

1863. AGASSIZ, ALEX. Descriptions of New Echinoderms. *Bull. Mus. Comp. Zool.*, Vol. I, 1863.

1874. ———Revision of the Echini. *Ill. Cat. Mus. Comp. Zool.*, No. 7. Cambridge, 1872–74.

1899. ANDERSON, F. M. The Geology of Point Reyes Peninsula. *Bull. Dept. Geol., Univ. Cal.*, Vol. II, 1897, No. 5, pp. 119–153, Pl. IV.

1902. ARNOLD, DELOS AND RALPH. The Marine Pliocene and Pleistocene Stratigraphy of the Coast of Southern California. *Jour. Geol.*, Vol. X, 1902, No. 2, pp. 117–138, Pls. I–V, figs. 1–7.

1895. ASHLEY, G. H. The Neocene Stratigraphy of the Santa Cruz Mountains of California. *Proc. Cal. Acad. Sci.*, 2nd Ser., Vol. V, 1895, pp. 273–367, Pls. XXII–XXV.

Also issued in Leland Stanford Junior University Publications, Geology and Paleontology, No. 1, 1895.

1863. BAIRD, WILLIAM. Collections made by Dr. Lyall, Dr. Forbes, R. N., and J. K. Lord, on the Northwest Boundary Survey, Vancouver Island, etc. *Proc. Zool. Soc.*, 1863, p. 66, 12 plates.

Sixteen species described, fourteen figured, but only nine seem to be new.

1863. BINNEY, W. G. Bibliography of North American Conchology. 2 vols., 8vo.

Published by the Smithsonian Institution, 1863–64. This publication catalogues all of the American species named by the authors quoted. Useful for books printed before 1860.

1825–27. BLAINVILLE, D. DE. Manuel de Malacologie et de Conchyliologie. 2 vols., 8vo, 190 plates. Paris, 1825–27.

1832. ——— Living and Fossil Purpuras, etc. *Ann. Nouvelles du Mus. Paris*, Vol. I, 1832, p. 189, with plates.

1878. BOWERS, STEPHEN. Geology of Santa Rosa Island from Notes taken by Dr. Lorenzo G. Yates. *Smithsonian Report* for 1877, pp. 316-320.

1881. BRAUNS, DAVID. Geology of the Environs of Tokio. *Mem. Sci. Dept., Univ. of Tokio*, No. 4, 1881.

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## EXPLANATION OF PLATE I.

(ALL FIGURES MAGNIFIED.)

Fig. 1. *Turbonilla (Lancea) pentalopha* DALL & BARTSCH. Type specimen. Longitude 8.5 mm.; ×6. 274

Fig. 1*a*. Same. Nuclear whorls more enlarged. 274

Fig. 2. *Turbonilla (Pyrgolampros) gibbosa* CARPENTER. Longitude 5.6 mm.; ×9.3. 279

Fig. 2*a*. Same. Nuclear whorls more enlarged. 279

Fig. 3. *Odostomia (Oscilla) æquisculpta* CARPENTER. Type specimen, not fully mature. Longitude 2 mm.; ×13. 284

Fig. 3*a*. Same. Nuclear whorls more enlarged. 284

Fig. 4. *Turbonilla (Pyrgiscus) auricoma* DALL & BARTSCH. Type specimen. Longitude 7.2 mm.; ×6.2. 274

Fig. 4*a*. Same. Nuclear whorls more enlarged. 274

Fig. 5. *Turbonilla (Pyrgolampros) lowei* DALL & BARTSCH. Type specimen. Longitude 7.2 mm.; ×6.2. 278

Fig. 5*a*. Same. Nuclear whorls more enlarged. 278

Fig. 6. *Odostomia (Oscilla) grammatospira* DALL & BARTSCH. Type specimens. Longitude 5.3 mm.; ×10. 285

Fig. 6*a*. Same. Nuclear whorls more enlarged. 285

Fig. 7. *Turbonilla (Pyrgolampros) arnoldi* DALL & BARTSCH. Type specimen. Longitude 7.6 mm.; ×6.2. 279

Fig. 8. *Odostomia (Chrysallida) diegensis* DALL & BARTSCH. Type specimen; the lower right-hand portion of the aperture defective. Longitude 4 mm.; ×11. 284

Fig. 9. *Turbonilla (Pyrgolampros) adleri* DALL & BARTSCH. Type specimen; the apex defective. Longitude 9.3 mm.; ×5. 280

Fig. 10. *Turbonilla (Strioturbonilla) torquata* var. *stylina* CARPENTER. Longitude 8 mm.; ×7.25. 272

Fig. 10*a*. Same. Nuclear whorls more enlarged. 272

Fig. 11. *Odostomia (Amaura) nuciformis* var. *avellana* CARPENTER. Type specimen. Longitude 9.1 mm.; ×5. 283

Fig. 12. *Odostomia (Evalea) stearnsii* DALL & BARTSCH. Type specimen. Longitude 5.2 mm.; ×9.2. 282

Fig. 13. *Odostomia (Amaura) pupiformis* CARPENTER. Type specimen. Longitude 6.5 mm.; ×7. 283

Fig. 14. *Odostomia tenuis* CARPENTER. Longitude 5.7 mm.; ×8. 281

Fig. 15. *Odostomia (Evalea) gouldii* CARPENTER. Longitude 5 mm.; ×9. 282

1 *a*

2 *a*

3 *a*

4 *a*

5 *a*

1

2

3

4

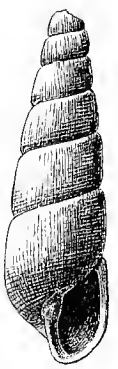
5

6 *a*

6

7

8



9

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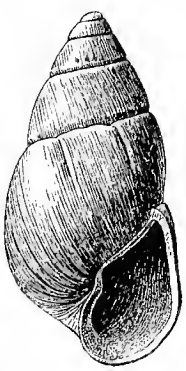

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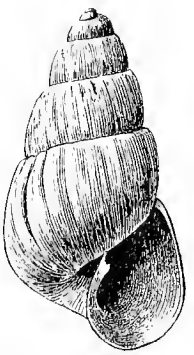

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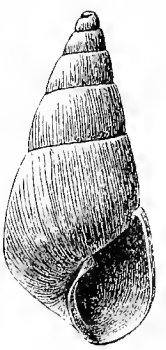

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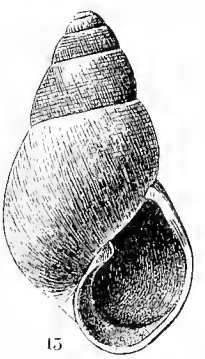

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## EXPLANATION OF PLATE II.

(ALL FIGURES MAGNIFIED.)

Fig. 1. *Turbonilla (Lancea) tridentata* CARPENTER. Longitude 12.8 mm.; ×5. 273
Fig. 1*a*. Same. Nuclear whorls more enlarged. 273
Fig. 2. *Turbonilla (Pyrgiscus) subcuspidata* CARPENTER. Type specimen. Longitude 6 mm.; ×9. 277
Fig. 2*a*. Same. Nuclear whorls more enlarged. 277
Fig. 3. *Turbonilla (Pyrgolampros) lowei* var. *pedroana* DALL & BARTSCH. Type specimen. Longitude 5.5 mm.; ×10. 279
Fig. 3*a*. Same. Nuclear whorls more enlarged. 279
Fig. 4. *Turbonilla torquata* GOULD. Longitude 10.6 mm.; ×6. 271
Fig. 4*a*. Same. Nuclear whorls more enlarged. 271
Fig. 5. *Turbonilla stearnsii* DALL & BARTSCH. Type specimen. Longitude 9.2 mm.; ×6.7. 271
Fig. 5*a*. Same. Nuclear whorls more enlarged. 271
Fig. 6. *Turbonilla (Pyrgiscus) crebrifilata* CARPENTER. Longitude 5.4 mm.; ×10.7. 276
Fig. 6*a*. Same. Nuclear whorls more enlarged. 276
Fig. 7. *Turbonilla (Pyrgiscus) tenuicula* GOULD. Longitude 6.1 mm.; ×9. 275
Fig. 7*a*. Same. Nuclear whorls more enlarged. 275
Fig. 8. *Turbonilla (Pyrgisculus) laminata* CARPENTER. Longitude 6.8 mm.; ×9. 277
Fig. 8*a*. Same. Nuclear whorls more enlarged. 277

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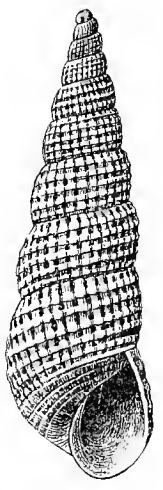
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## EXPLANATION OF PLATE III.

Fig. 1. *Paracyathus pedroënsis* VAUGHAN. View of calice. Greater diameter 12 mm.; ×2.8. 88

Fig. 1*a*. Same. Upright view of corallum. Height 18 mm.; ×1.2. 88

Fig. 2. *Caryophyllia californica* VAUGHAN. View of calice. Greater diameter 11.5 mm.; ×2.7. 87

Fig. 2*a*. Same. Upright view of corallum. Height 13 mm.; ×1.2. 87

Fig. 3. *Caryophyllia pedroensis* VAUGHAN. View of calice. Greater diameter 13.5 mm.; ×2.6 87

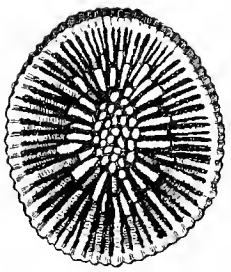
Fig. 3*a*. Same. Upright view of corallum. Height 25.5 mm.; ×1.2. 87

Fig. 4. *Caryophyllia arnoldi* VAUGHAN. Upright view of corallum. Height 16.5 mm.; ×2.5. 86

Fig. 4*a*. Same. View of calice. Greater diameter 16 mm.; ×2.5. 86

Fig. 5. *Turbonilla (Pyrgiscus) latifundia* DALL & BARTSCH. Type specimen. Longitude 5.8 mm.; ×7.4. 275

Fig. 5*a*. Same. Nuclear whorls more magnified. 275



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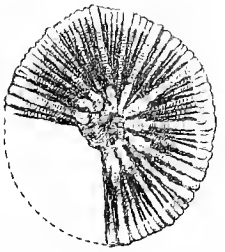

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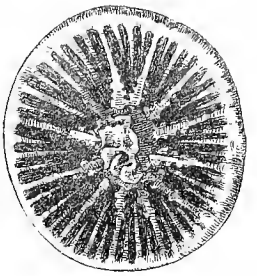

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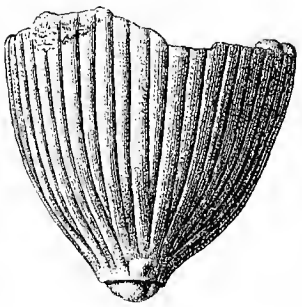

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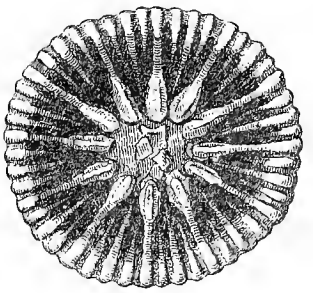

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## EXPLANATION OF PLATE IV.

Fig. 1. *Nassa cerritensis*, sp. nov. Upper San Pedro series, Los Cerritos. Type specimen. Longitude 31 mm.; ×1.3. 231

Fig. 2. *Volvula cylindrica* CARPENTER. Lower San Pedro series, Deadman Island. Longitude 7 mm.; ×2. 191

Fig. 3. *Nassa californiana* CONRAD. Upper San Pedro series, San Pedro. Longitude 38 mm.; ×3. 231

Fig. 4. *Bittium californicum* DALL & BARTSCH. Lower San Pedro series, San Pedro. Longitude 5.6 mm.; ×4. 291

Fig. 5. *Siphonalia kellettii* FORBES. Upper San Pedro series, San Pedro. Longitude 112 mm.; natural size. 229

Fig. 6. *Nassa versicolor* var. *hooveri*, var. nov. Upper San Pedro series, San Pedro. Type specimen. Longitude 14 mm.; ×2.7. 362

Fig. 7. *Fusus rugosus* TRASK. Lower San Pedro series, Deadman Island. Longitude 50 mm.; ×1.3. 226

Fig. 8. *Seila assimilata* C. B. ADAMS. Lower San Pedro series, San Pedro. Longitude 10 mm.; ×4. 290

Fig. 9. *Marginella (Volvarina) varia* SOWERBY. Lower San Pedro series, Deadman Island. Longitude 9.2 mm.; ×2.6. 222

Fig. 10. *Mitromorpha intermedia*, sp. nov. Lower San Pedro series, Deadman Island. Type specimen. Longitude 9.6 mm.; ×4. 223

Fig. 11. *Bittium rugatum* CARPENTER. Upper San Pedro series, San Pedro. Longitude 13 mm ; ×3.1. 295

Fig. 12. *Rissoa acutelirata* CARPENTER. Upper San Pedro series, San Pedro. Longitude 2.1 mm.; ×6.7. 305

Fig. 13. *Turritella jewettii* CARPENTER. Pliocene, Deadman Island. Longitude 69 mm.; natural size. 300

Fig. 14. *Odostomia (Ivara) terricula* (CARPENTER) D. & B. Lower San Pedro series, Deadman Island. Longitude 4 mm.; ×6.7. 285

Fig. 15. *Fusus barbarensis* TRASK. Pliocene, Deadman Island. Longitude 50 mm.; ×1.5. 224

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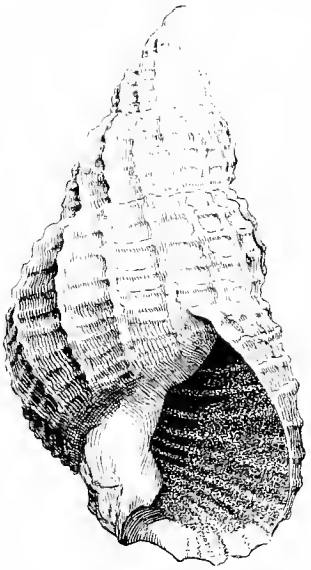
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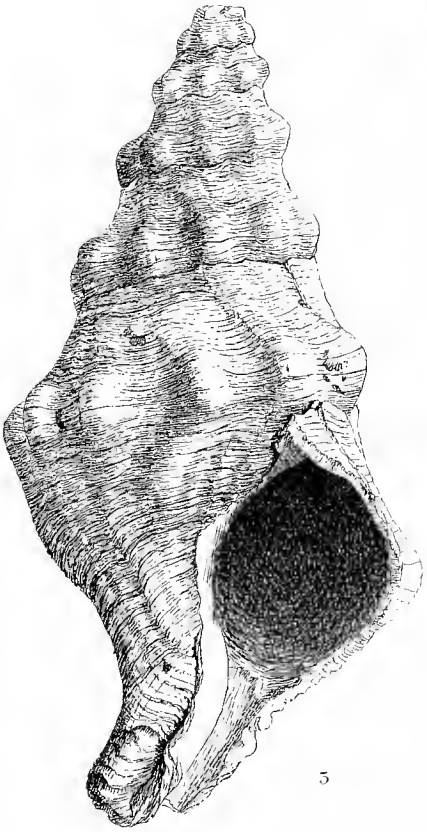
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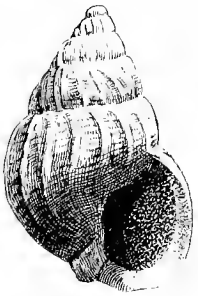
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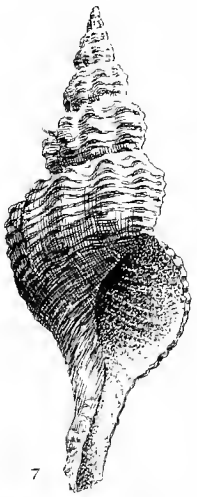
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## EXPLANATION OF PLATE V.

Fig. 1. *Ocinebra barbarensis* GABB. Lower San Pedro series, Deadman Island. Longitude 19 mm.; ×2. 254

Fig. 2. *Ocinebra poulsoni* NUTTALL. Upper San Pedro series, San Pedro. Longitude 31 mm.; ×2.7. 260

Fig. 3. *Scala tincta* CARPENTER. Upper San Pedro series, San Pedro. Longitude 19 mm.; ×2. 265

Fig. 4. *Scala indianorum* CARPENTER. Upper San Pedro series, San Pedro. Longitude 21 mm.; ×2. 264

Fig. 5. *Ocinebra turida* var. *cerritensis*, var. nov. Upper San Pedro series, Crawfish George's. Type specimen. Longitude 17 mm.; ×1.3. 258

Fig. 6. *Columbella (Æsopus) chrysalloidea* CARPENTER. Upper San Pedro series, San Pedro. Longitude 11 mm.; ×2. 237

Fig. 7. *Pleurotoma (Borsonia) bartschi*, sp. nov. Lower San Pedro series, Deadman Island. Short variety. Longitude 14 mm.; ×1.3. 200

Fig. 8. *Drillia hemphilli* STEARNS. Upper San Pedro series, San Pedro. Longitude 16 mm.; ×2.5. 204

Fig. 9. *Ocinebra keepi*, sp. nov. Upper San Pedro series, Deadman Island. Type specimen. Longitude 35 mm.; ×2. 256

Fig. 10. *Drillia inermis* HINDS. Upper San Pedro series, San Pedro. Longitude 22 mm.; ×1.25. 205

Fig. 11. *Amphissa ventricosa*, sp. nov. Lower San Pedro series, Deadman Island. Type specimen. Longitude 13 mm.; ×2. 242

Fig. 12. *Ocinebra lurida* var. *aspera* BAIRD. Upper San Pedro series, San Pedro. Longitude 28 mm.; ×2. 257

Fig. 13. *Margarita optabilis* var. *nodosa*, var. nov. Lower San Pedro series, San Pedro. Type specimen, tilted back. Altitude 6.9 mm.; ×4. 332

Fig. 14. *Margarita optabilis* var. *knechti*, var. nov. Lower San Pedro series, San Pedro. Type specimen, tilted back. Altitude 8 mm.; ×3. 332

Fig. 15. *Ocinebra micheli* FORD. Upper San Pedro series, Crawfish George's. Longitude 16 mm.; ×2.5. 259

Fig. 16. *Margarita parcipicta* var. *pedroana*, var. nov. Lower San Pedro series, San Pedro. Type specimen, tilted back. Altitude 5.5 mm.; ×4. 333

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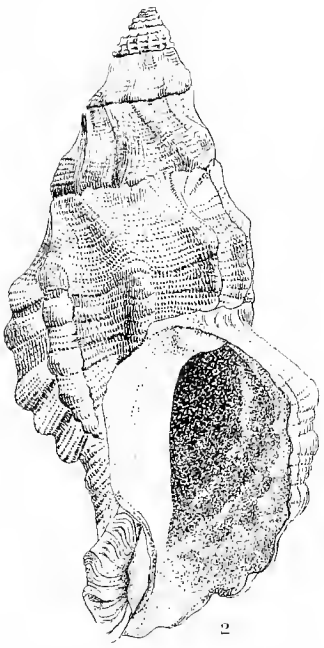
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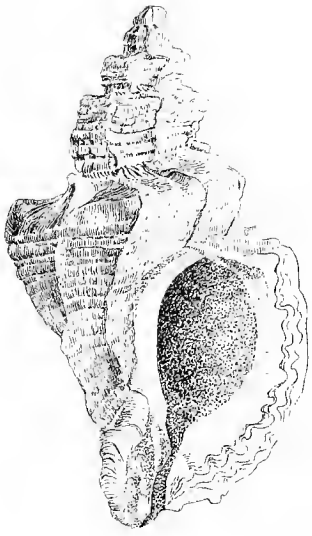
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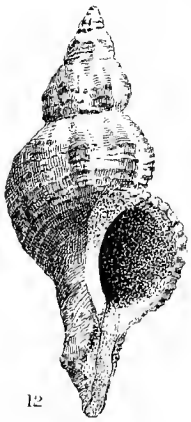
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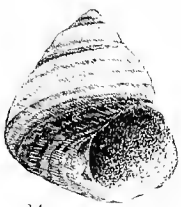
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## EXPLANATION OF PLATE VI.

Fig. 1. *Tritonium (Priene) oregonensis* REDFIELD. Pliocene, Deadman Island. Longitude 102 mm.; natural size. 286

Fig. 2. *Pleurotoma (Borsonia) dalli*, sp. nov. Lower San Pedro series, Deadman Island. Type specimen. Longitude 23 mm.; ×2. 201

Fig. 3. *Mangilia interfossa* var. *pedroana*, var. nov. Lower San Pedro series, Deadman Island. Type specimen. Longitude 6 mm.; ×5. 213

Fig. 4. *Trophon (Boreotrophon) stuarti* SMITH. Pliocene, Deadman Island. Longitude 30 mm.; ×2. 252

Fig. 5. *Trophon (Boreotrophon) orpheus* var. *præcursor*, var. nov. Pliocene, Deadman Island. Type specimen. Longitude 15 mm.; ×2.7. 253

Fig. 6. *Trophon (Boreotrophon) cerritensis*, sp. nov. Lower San Pedro series, Deadman Island. Type specimen. Longitude 32 mm.; ×2. 249

Fig. 7. *Columbella (Æsopus) oldroydi*, sp. nov. Lower San Pedro series, Deadman Island. Type specimen. Longitude 8.5 mm.; ×2.6. 238

Fig. 8. *Trophon (Boreotrophon) gracilis* PERRY. Pliocene, Deadman Island. Longitude 26 mm.; ×2. 250

Fig. 9. *Trophon (Boreotrophon) multicostatus* ESCHSCHOLTZ. Lower San Pedro series, Deadman Island. Longitude 10 mm.; ×2.6. 251

Fig. 10. *Trophon (Boreotrophon) scalariformis* GOULD. Lower San Pedro series, Deadman Island. Longitude 15.5 mm.; ×2.6. 252

Fig. 11. *Bittium williamsoni*, sp. nov. Upper San Pedro series, San Pedro. Type specimen. Longitude 2.9 mm.; ×7.2. 295

Fig. 12. *Trophon (Boreotrophon) pedroana*, sp. nov. Lower San Pedro series, Deadman Island. Type specimen. Longitude 12 mm.; ×3.3. 251

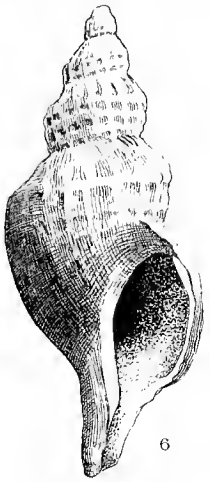
Fig. 13. *Pleurotoma (Spirotropsis) smithi*, sp. nov. Pliocene, Deadman Island. Type specimen. Longitude 36 mm.; ×1.5. 216

Fig. 14. *Bittium (Styliferina) tenuisculpta* CARPENTER. Lower San Pedro series, Deadman Island. Longitude 6.1 mm.; ×4. 296

Fig. 15. *Mangilia interlirata* STEARNS. Lower San Pedro series, Deadman Island. Longitude 9.1 mm.; ×3. 213

Fig. 16. *Mangilia oldroydi*, sp. nov. Lower San Pedro series, Deadman Island. Type specimen. Longitude 16.1 mm.; ×2.5. 213

Fig. 17. *Mangilia sculpturata* DALL. Pliocene, Deadman Island. Longitude 11 mm.; ×3. 214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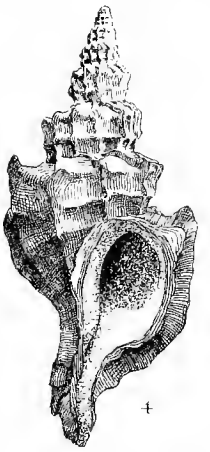
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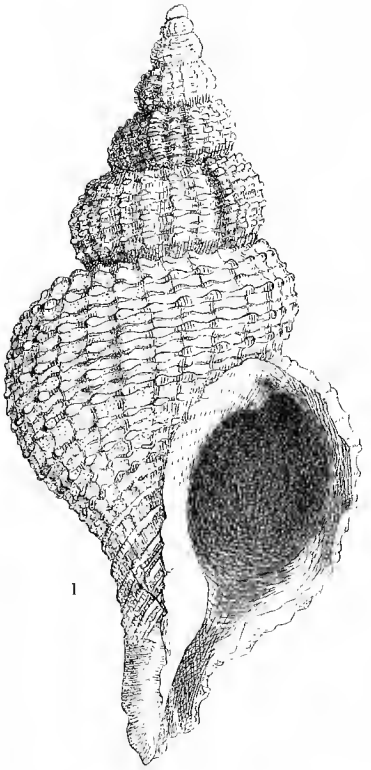
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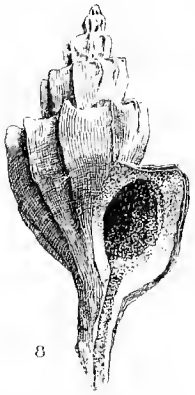
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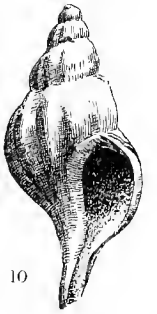
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## EXPLANATION OF PLATE VII.

Fig. 1. *Murex (Chicoreus) leeanus* DALL. Upper San Pedro series, San Pedro. Longitude 55 mm.; ×1.3. 243

Fig. 2. *Solariella peramabilis* CARPENTER. Pliocene, Deadman Island. Altitude 14 mm.; ×1.5. 335

Fig. 3. *Pleurotoma (Dolichotoma) cooperi*, sp. nov. Upper San Pedro series, San Pedro. Longitude 64 mm.; natural size. 203

Fig. 4. *Admete gracilior* CARPENTER. Lower San Pedro series, Deadman Island. Longitude 10.5 mm.; ×3.3. 219

Fig. 5. *Cancellaria tritonidea* GABB. Upper San Pedro series, San Pedro. Longitude 90 mm.; natural size. 218

Fig. 6. *Chrysodomus tabulatus* BAIRD. Pliocene, Deadman Island. Longitude 80 mm.; natural size. 228

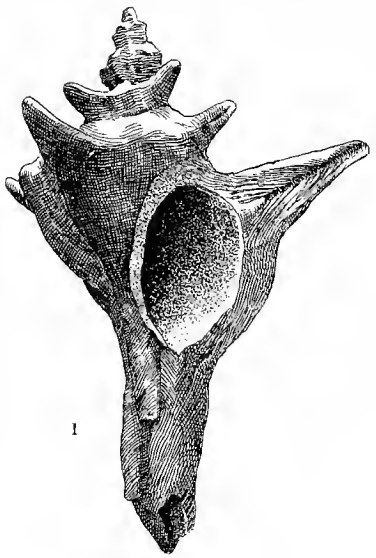
Fig. 7. *Chrysodomus rectirostris* CARPENTER. Lower San Pedro series, Deadman Island. Longitude 28 mm.; ×2. 228

Fig. 8. *Cancellaria cooperi* GABB. Upper San Pedro series, San Pedro. Longitude 80 mm.; natural size. 217

Fig. 9. *Mangilia angulata* CARPENTER. Lower San Pedro series, Deadman Island. Longitude 8 mm.; ×3.6. 212

Fig. 10. *Bela fidicula* GOULD. Lower San Pedro series, Deadman Island. Longitude 11 mm.; ×4. 209

Fig. 11. *Solariella cidaris* CARPENTER. Pliocene, Deadman Island. Altitude 42 mm.; natural size. 334



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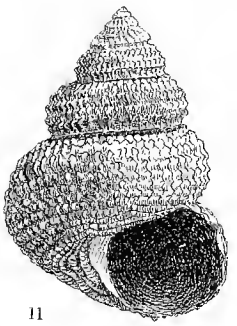

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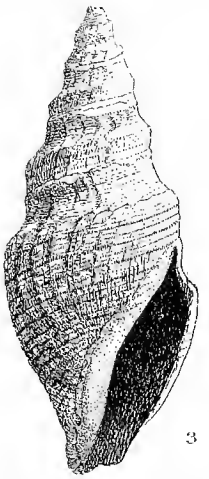

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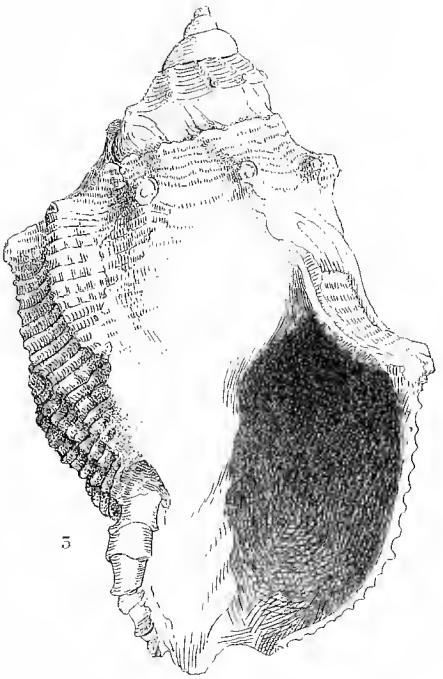

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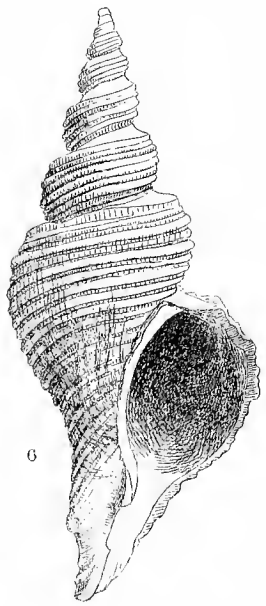

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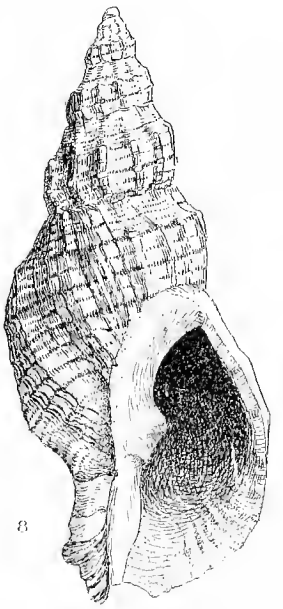

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## EXPLANATION OF PLATE VIII.

Fig. 1. *Mangilia painei*, sp. nov. Lower San Pedro series, Deadman Island. Type specimen. Longitude 12.5 mm ; ×3.4. 214

Fig. 2. *Paludestrina curta*, sp. nov. Lower San Pedro series, San Pedro. Type specimen. Longitude 3.8 mm.; ×7. 305

Fig. 3. *Paludestrina stokesi*, sp. nov. Lower San Pedro series, San Pedro. Type specimen. Longitude 4.6 mm.; ×5.4. 305

Fig. 4. *Dentalium indianorum* CARPENTER. Lower San Pedro series, Deadman Island. Longitude 38 mm.; natural size. 186

Fig. 5. *Drillia renaudi*, sp. nov. Lower San Pedro series, Deadman Island. Type specimen. Longitude 16 mm.; ×3. 208

Fig. 6. *Cæcum californicum* DALL. Lower San Pedro series, Deadman Island. Longitude 2.9 mm.; ×5.8. 297

Fig. 7. *Drillia merriami*, sp. nov. Lower San Pedro series, Deadman Island. Type specimen. Longitude 14 mm.; ×3.2. 207

Fig. 8. *Bulla quoyi* GRAY. Upper San Pedro series, San Pedro. A young specimen. Longitude 8 mm.; ×3. 193

Fig. 9. *Eupleura muriciformis* var. *curta*, var. nov. Upper San Pedro series, San Pedro. Type specimen. Longitude 15 mm.; ×3.2. 249

Fig. 10. *Cæcum crebricinctum* CARPENTER. Lower San Pedro series, San Pedro Bluff. Longitude 5.5 mm.; ×6. 298

Fig. 11. *Lacuna solidula* (LOVÉN) CARPENTER. Upper San Pedro series, San Pedro. A somewhat decorticated specimen. Longitude 10 mm.; ×2.5. 303

Fig. 12. *Dentalium pseudohexagonum* DALL. Lower San Pedro series, Deadman Island. Longitude 15.5 mm.; ×3. 186

Fig. 12*a*. Sectional view of same; ×3. 186

Fig. 13. *Drillia pudica* HINDS. Upper San Pedro series, San Pedro. Longitude 11 mm.; ×3.5. 208

Fig. 14. *Bela sanctæ-monicæ*, sp. nov. Lower San Pedro series (Pleistocene), Port Los Angeles. Type specimen. Longitude 12 mm.; ×3. 210

Fig. 15. *Cadulus nitentior* CARPENTER. Lower San Pedro series, Deadman Island. Longitude 10 mm.; ×3.3. 187

Fig. 16. *Cæcum magnum* STEARNS. Lower San Pedro series, Deadman Island. Longitude 4.7 mm.; ×5.3. 298

Fig. 17. *Drillia johnsoni*, sp. nov. Upper San Pedro series, San Pedro. Type specimen, apex broken off. Longitude 29 mm.; ×2. 206

Fig. 18. *Haminea virescens* SOWERBY. Upper San Pedro series, San Pedro. Longitude 7 mm.; ×3.25. 194

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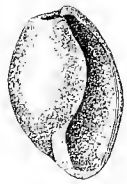
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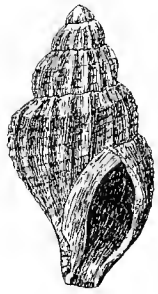
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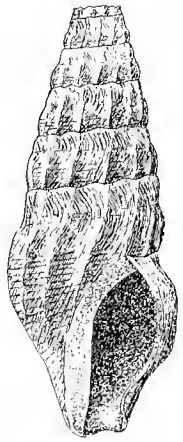
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## EXPLANATION OF PLATE IX.

Fig. 1. *Pleurotoma (Borsonia) bartschi*, sp. nov. Lower San Pedro series, Deadman Island. Type specimen. Longitude 18.5 mm.; ×3.4. 200

Fig. 2. *Bittium quadrifilatum* CARPENTER. Lower San Pedro series, Deadman Island. Longitude 10 mm.; ×3. 292

Fig. 3. *Mangilia striosa* C. B. ADAMS. Upper San Pedro series, Los Cerritos. Longitude 9.4 mm.; ×3. 215

Fig. 4. *Pleurotoma (Leucosyrinx) pedroana*, sp. nov. Lower San Pedro series, Deadman Island. Type specimen. Longitude 17 mm.; ×3. 202

Fig. 5. *Mangilia hooveri*, sp. nov. Upper San Pedro series, San Pedro. Type specimen. Longitude 11 mm.; ×3. 212

Fig. 6. *Actæon (Rictaxis) punctocœlata* CARPENTER. Upper San Pedro series, San Pedro. Longitude 5.9 mm.; ×3. 189

Fig. 7. *Mangilia (Taranis) strongi*, sp. nov. Lower San Pedro series, Deadman Island. Type specimen. Longitude 12 mm.; ×3.5. 215

Fig. 8. *Columbella (Anachis) minima*, sp. nov. Upper San Pedro series, San Pedro. Type specimen. Longitude 5.5 mm.; ×3. 237

Fig. 9. *Eulima hastata* SOWERBY. Upper San Pedro series, San Pedro. Longitude 10 mm.; ×3.4. 268

Fig. 10. *Mangilia (Cythara) branneri*, sp. nov. Lower San Pedro series, Deadman Island. Type specimen. Longitude 10 mm.; ×3.2. 211

Fig. 11. *Ocinebra lurida* var. *cancellina* PHILIPPI. Upper San Pedro series, San Pedro. Longitude 21 mm.; ×2. 257

Fig. 12. *Eulima micans* CARPENTER. Lower San Pedro series, Deadman Island. Longitude 12 mm.; ×3.5. 269

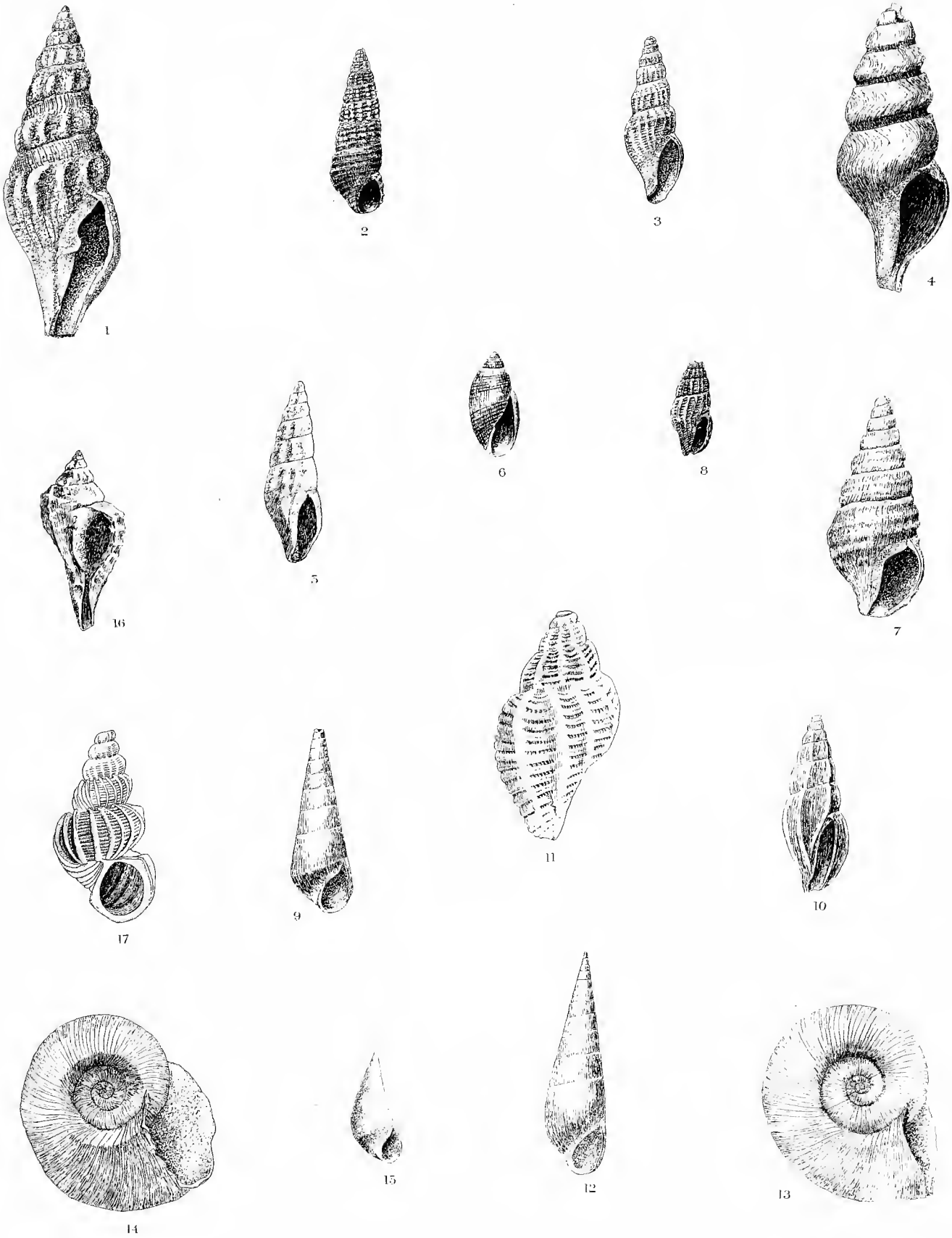
Fig. 13. *Planorbis tumidus* PFEIFFER. Upper San Pedro series, San Pedro. Maximum diameter 12.7 mm.; ×3. 195

Fig. 14. *Planorbis vermicularis* GOULD. Upper San Pedro series, San Pedro. Maximum diameter 11.5 mm.; ×3. 195

Fig. 15. *Eulima falcata* CARPENTER. Lower San Pedro series, Deadman Island. Longitude 7 mm.; ×3. 268

Fig. 16. *Eupleura muriciformis* BRODERIP. Upper San Pedro series, San Pedro. Longitude 33 mm.; natural size. 248

Fig. 17. *Scala bellastriata* CARPENTER. Figure of living shell from San Pedro. Longitude 18 mm.; ×2. 263

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## EXPLANATION OF PLATE X.

Fig. 1. *Pleurotoma (Borsonia) hooveri*, sp. nov. Lower San Pedro series, Deadman Island. Type specimen. 12.7 mm.; ×3. 201

Fig. 2. *Phorcus pulligo* MARTYN. Upper San Pedro series, Crawfish George's. Specimen slightly tilted back. Altitude 17.5 mm.; natural size. 328

Fig. 3. *Tornatina culcitella* GOULD. Lower San Pedro series, Deadman Island. Longitude 11 mm.; ×3.2. 190

Fig. 4. *Columbella solidula* var. *præcursor*, var. nov. Upper San Pedro series, San Pedro. Type specimen. Longitude 14.4 mm.; ×3.5. 236

Fig. 5. *Tornatina cerealis* GOULD. Lower San Pedro series, San Pedro. Longitude 4.5 mm.; ×5.5. 189

Fig. 6. *Actæon traskii* STEARNS. Upper San Pedro series, San Pedro. Longitude 14 mm.; ×3. 188

Fig. 7. *Columbella (Astyris) tuberosa* CARPENTER. Upper San Pedro series, San Pedro. Longitude 6.5 mm.; ×3. 240

Fig. 8. *Columbella (Astyris) gausapata* GOULD. Upper San Pedro series, San Pedro. Longitude 10 mm.; ×3. 239

Fig. 9. *Columbella (Astyris) californiana* GASKOIN. Lower San Pedro series, Deadman Island. Longitude 10 mm.; ×3. 238

Fig. 10. *Columbella (Astyris) gausapata* var. *carinata* HINDS. Upper San Pedro series, San Pedro. Longitude 7.7 mm.; ×3. 240

Fig. 11. *Tornatina eximia* BAIRD. Pliocene, Deadman Island. Longitude 12.5 mm.; ×3. 190

Fig. 12. *Polynices (Neverita) recluziana* PETIT. Upper San Pedro series, San Pedro. Typical shape. Altitude 17.5 mm.; natural size. 314

Fig. 13. *Natica (Cryptonatica) clausa* BRODERIP & SOWERBY. Pliocene, Deadman Island. Shouldered variety. Altitude 26 mm.; natural size. 313

Fig. 14. *Polynices (Lunatia) lewisii* GOULD. Upper San Pedro series, San Pedro. Longitude 75 mm.; ×0.66. 315

Fig. 15. *Margarita pupilla* GOULD. Pliocene, Deadman Island. Altitude 7.5 mm.; ×3. 333

Fig. 16. *Delphinoidea coronadoensis*, sp. nov. Pleistocene, Spanish Bight, San Diego. Type specimen, view from above. Maximum diam. 2 mm.; ×5. 320

Fig. 17. Same specimen viewed from in front; ×5. 320

Fig. 18. *Cylichna alba* BROWN. Lower San Pedro series, Deadman Island. Longitude 12 mm.; ×1.5. 192

Fig. 19. *Chlorostoma montereyi* KIENER. Upper San Pedro series, Crawfish George's. Specimen slightly tilted back. Altitude 28 mm.; natural size. 326

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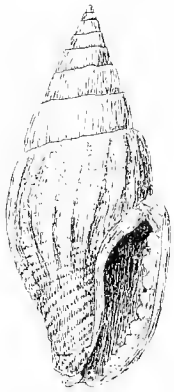
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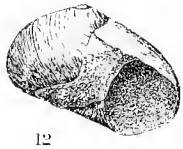
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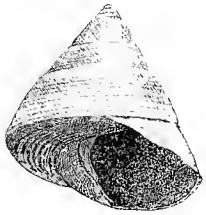
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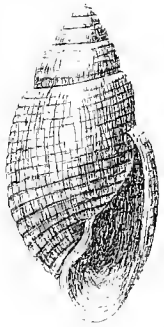
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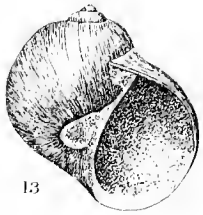
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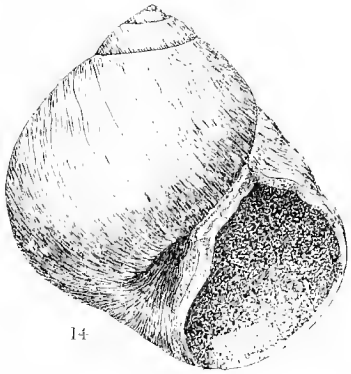
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## EXPLANATION OF PLATE XI.

Fig. 1. *Pecten (Plagioctenium) newsomi*, sp. nov. Upper San Pedro series, Los Cerritos. Type specimen, left valve. Altitude 26 mm.; ×1.4. 113

Fig. 1*a*. Same specimen. Outline, showing convexity of valve. ×1.4. 113

Fig. 2. *Pecten (Chlamys) hericeus* GOULD. Pliocene, Deadman Island. Exterior of left valve. Altitude 50 mm.; natural size. 110

Fig. 3. *Pecten (Plagioctenium) ventricosus* SOWERBY. Upper San Pedro series, San Pedro. Exterior of left valve. Altitude 36 mm.; ×1.3. 114

Fig. 3*a*. Same specimen. Outline, showing convexity of valve; ×1.3. 114

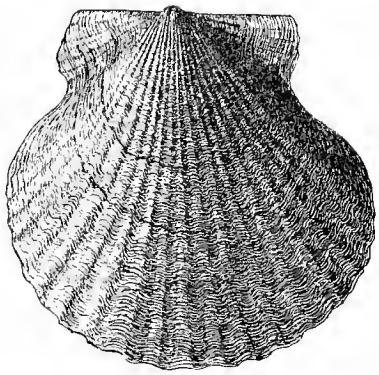
Fig. 4. *Pecten (Chlamys) hastatus* SOWERBY. Pliocene, Deadman Island. Left valve, exterior view. Altitude 38 mm.; ×1.3. 109

Fig. 4*a*. Same specimen. Outline, showing convexity of valve; ×1.3. 109

Fig. 5. *Pecten (Chlamys) hericeus* var. *strategus* DALL. Lower San Pedro series, Deadman Island. Exterior of right valve. Altitude 21 mm.; ×1.3. 110

Fig. 6. *Pecten (Plagioctenium) ventricosus* SOWERBY. Upper San Pedro series, San Pedro. Exterior of left valve. Altitude 56 mm.; natural size. 114

Fig. 6*a*. Same specimen. Outline, showing convexity of valve; natural size. 114



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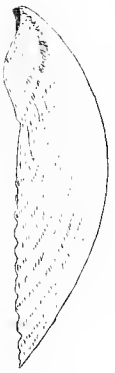

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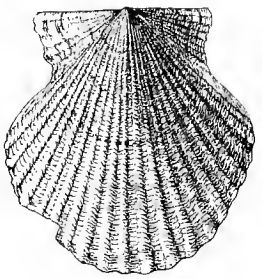

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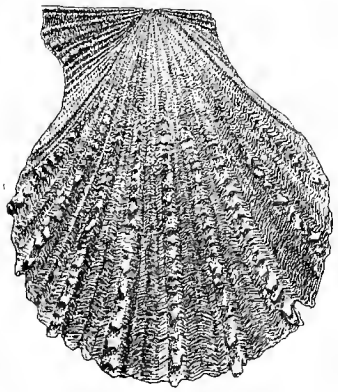

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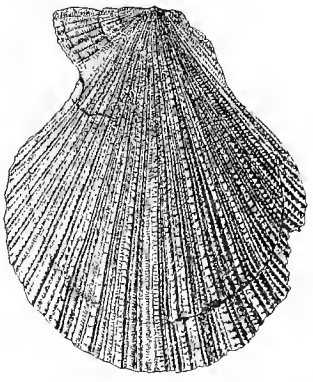

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## EXPLANATION OF PLATE XII.

Fig. 1. *Pecten (Pecten) dentatus* SOWERBY. Living shell from Gulf of California. Exterior of left or flat valve. Altitude 58 mm.; natural size. 104

Fig. 1*a*. Same specimen. Outline, showing convexity of right valve; natural size. 104

Fig. 2. *Pecten (Chlamys) latiauritus* CONRAD. Upper San Pedro series, San Pedro. Exterior of left valve. Altitude 23 mm.; ×1 3. 111

Fig. 2*a*. Same specimen. Outline, showing convexity of same valve; ×1.3. 111

Fig. 3. *Pecten (Pecten) stearnsii* DALL. Pliocene, San Diego. Exterior of left or flat valve. Altitude 65.5 mm.; natural size. 106

Fig. 4. *Pecten (Chlamys) latiauritus* var. *monotimeris* CONRAD. Upper San Pedro series, San Pedro. Exterior of left valve. Altitude 20.5 mm.; ×1.3. 112

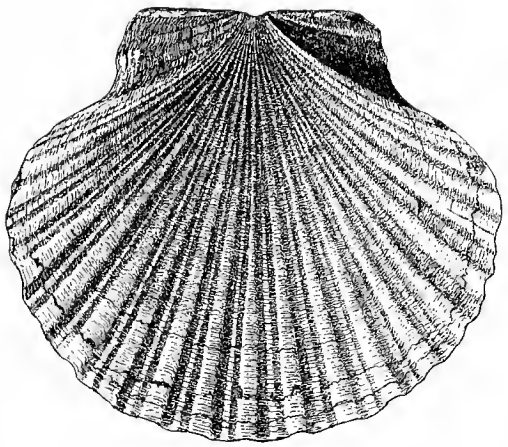
Fig. 4*a*. Same specimen. Outline, showing convexity of same valve; ×1.3. 112

Fig. 5. *Pecten (Pecten) diegensis* DALL. Living shell, Monterey. Outline, showing convexity of right valve (which is the same as the convexity of the right valve of *P. stearnsii*). Altitude 72 mm.; natural size. 106

Fig. 6. *Pecten (Chlamys) jordani*, sp. nov. Pliocene, Deadman Island. Type specimen, exterior of right valve. Altitude 51 mm.; ×0.9. 111

Fig. 7. Same specimen, exterior of left valve; ×0.9. 111

Fig. 8. *Pecten (Chlamys) latiauritus* var. *fragilis*, var. nov. Upper San Pedro series, San Pedro. Type specimen, exterior of right valve. Altitude 25 mm.; ×1.3. 112



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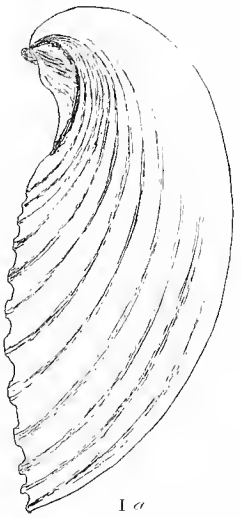

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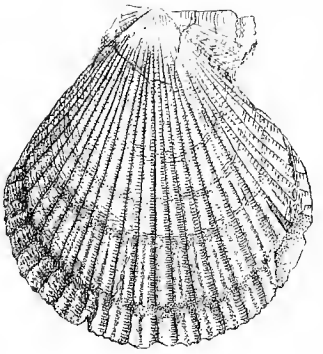

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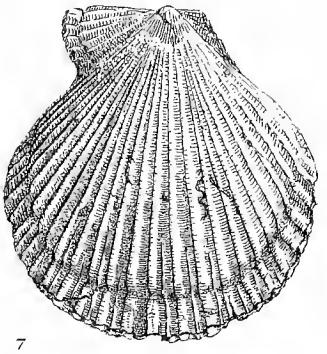

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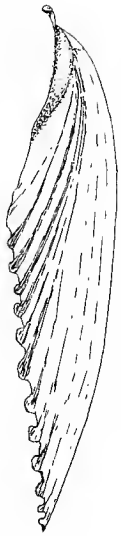

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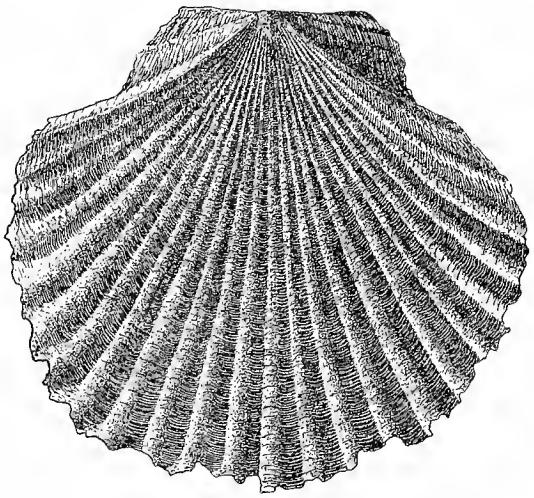

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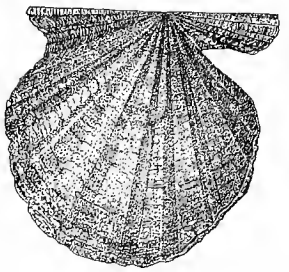

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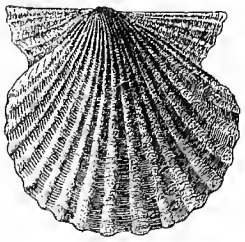

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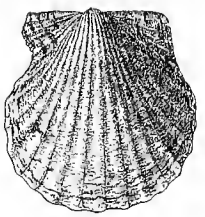

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## EXPLANATION OF PLATE XIII.

Fig. 1. *Cooperella subdiaphana* CARPENTER. Lower San Pedro series, Deadman Island. Interior, showing hinge. Longitude 12.5 mm.; ×5. 153

Fig. 2. *Callista subdiaphana* var. *pedroana*, var. nov. Lower San Pedro series, Deadman Island. Type specimen. Longitude 33 mm.; ×0.8. 144

Fig. 3. *Aligena cerritensis*, sp. nov. Upper San Pedro series, Los Cerritos. Type specimen, view of interior. Longitude 10.9 mm.; ×3. 138

Fig. 4. *Callista subdiaphana* CARPENTER. Pliocene, Deadman Island. Longitude 45 mm.; ×0.8. 144

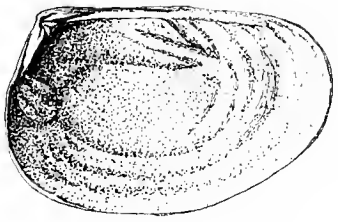
Fig. 5. *Psephis tantilla* GOULD. Lower San Pedro series, Deadman Island. View of interior. Longitude 6 mm.; ×4. 133

Fig. 6. *Pecten (Patinopecten) caurinus* GOULD. Pliocene, Deadman Island. Exterior of left valve. Altitude 122 mm.; ×0.8. 107

Fig. 7. *Tellina (Moerella) salmonea* CARPENTER. Lower San Pedro series, Deadman Island. Interior of right valve. Longitude 14 mm.; ×3.3. 157

Fig. 8. *Donax lævigata* DESHAYES. Upper San Pedro series, San Pedro. Interior view. Longitude 21 mm.; ×2.5. 170

Fig. 9. *Donax californica* CONRAD. Lower San Pedro series, Deadman Island. Interior view. Longitude 17 mm.; ×2.5. 170



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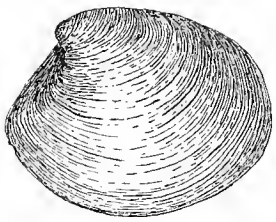

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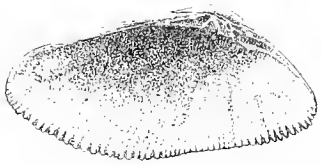

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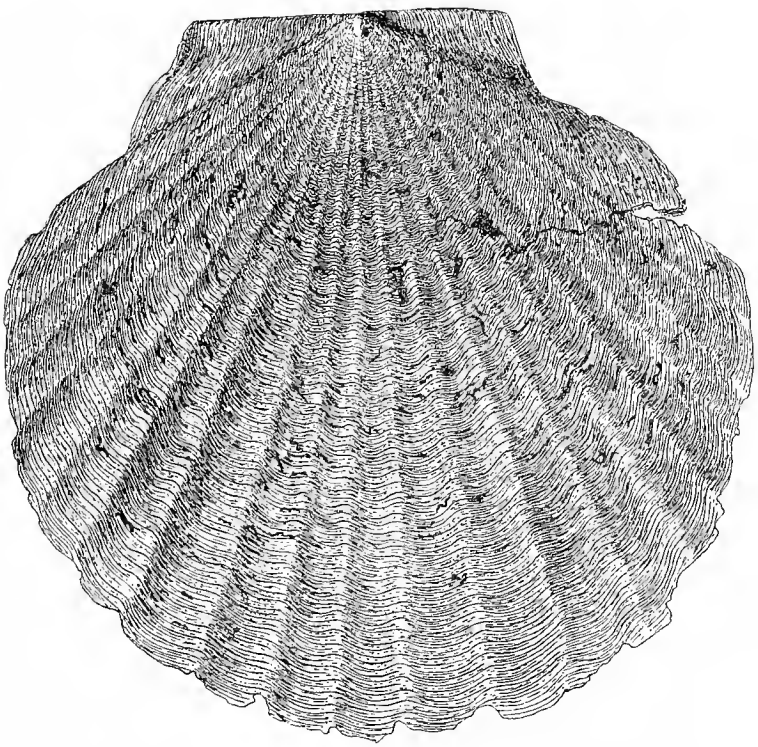

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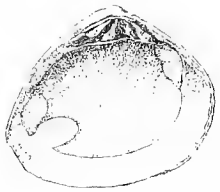

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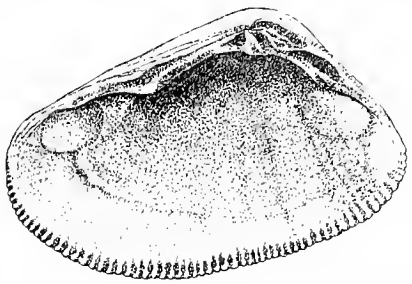

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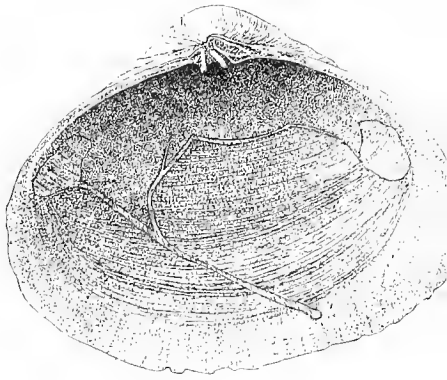

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## EXPLANATION OF PLATE XIV.

Fig. 1. *Venus (Chione) succincta* VALENCIENNES. Upper San Pedro series, San Pedro. Exterior of right valve. Longitude 54 mm.; natural size. 149

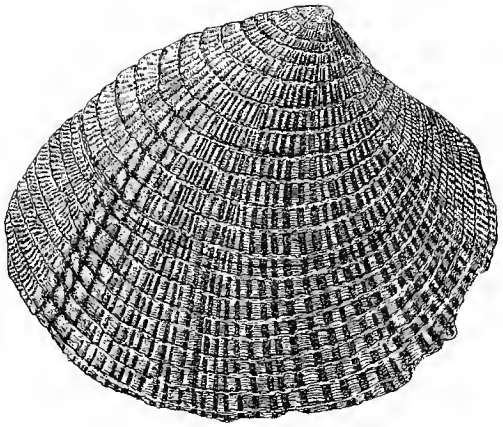
Fig. 2. *Venus (Chione) fluctifraga* SOWERBY. Upper San Pedro series, San Pedro. Exterior of right valve. Longitude 25 mm.; ×1.7. 147

Fig. 3. *Venus (Chione) neglecta* SOWERBY. Upper San Pedro series, San Pedro. Longitude 30 mm.; ×2.2. 148

Fig. 4. *Tapes staminea* CONRAD. Upper San Pedro series, San Pedro. Longitude 50 mm.; natural size. 150

Fig. 5. *Tapes lacinaata* CARPENTER. Upper San Pedro series, Los Cerritos. Longitude 10 mm.; ×1.1. 150

Fig. 6. *Tapes tenerrima* CARPENTER. Upper San Pedro series, San Pedro. Longitude 84 mm.; natural size. 151



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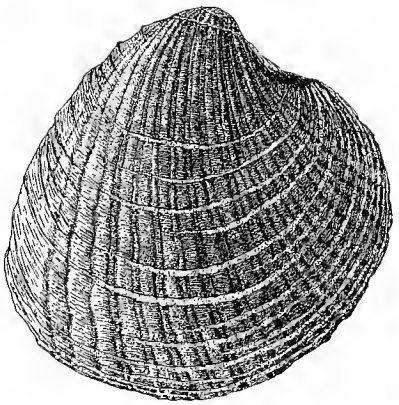

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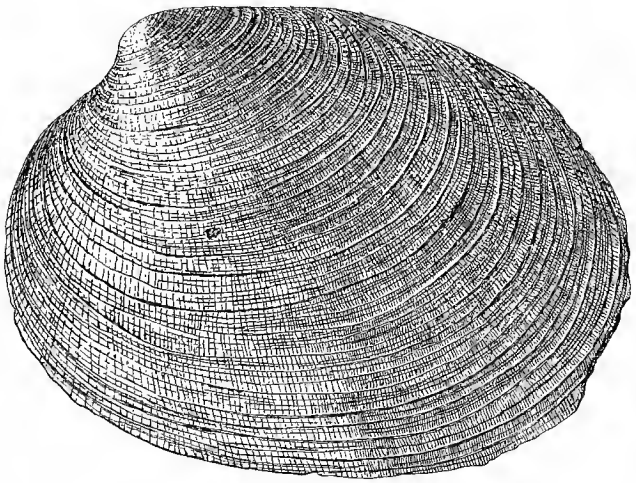

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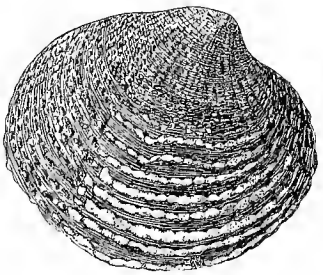

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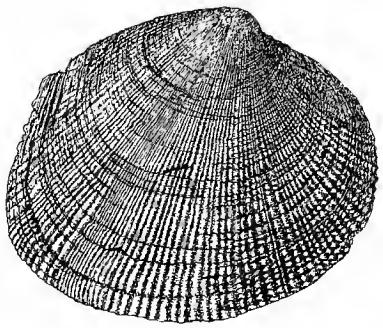

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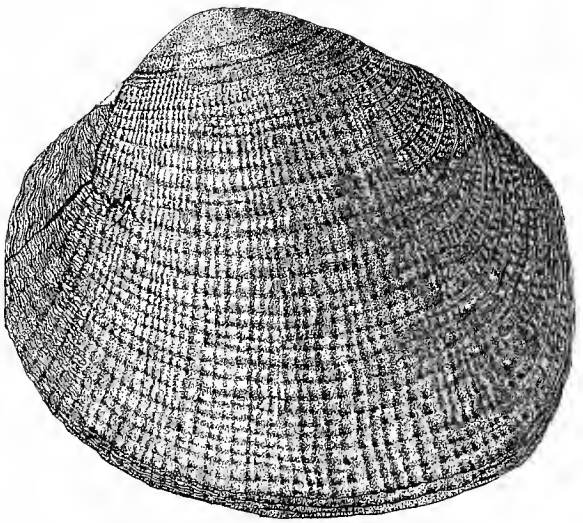

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## EXPLANATION OF PLATE XV.

Fig. 1. *Semele pulchra* SOWERBY. Upper San Pedro series, San Pedro. Longitude 15 mm.; ×3.3. 166

Fig. 1*a*. Same. Outline, showing convexity of valve; ×3.3. 166

Fig. 2. *Tellina* (*Angulus*) *buttoni* DALL. Upper San Pedro series, San Pedro. Interior view. Longitude 13.5 mm.; ×4.6. 157

Fig. 3. Same as fig. 2. Exterior view; ×4.6. 157

Fig. 4. *Semele pulchra* var. *montereyi*, var. nov. Lower San Pedro series, Deadman Island. Longitude 14 mm.; ×3.3. 166

Fig. 4*a*. Same. Outline, showing convexity of valve; ×3.3. 166

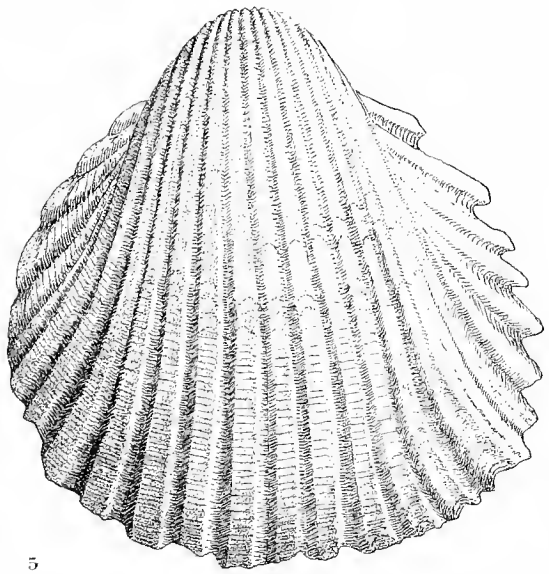
Fig. 5. *Thyasira bisecta* CONRAD. Pliocene, Deadman Island. Longitude 74 mm.; ×1.1. 135

Fig. 6. *Cardium* (*Ringicardium*) *procerum* SOWERBY. Upper San Pedro series, San Pedro. Exterior view. Longitude 73 mm.; natural size. 139

Fig. 7. *Tellina* (*Angulus*) *idæ* DALL. Upper San Pedro series, Los Cerritos. Longitude 62 mm.; ×0.7. 158

Fig. 8. *Tellina* (*Angulus*) *bodegensis* HINDS. Upper San Pedro series, San Pedro. Longitude 50 mm.; natural size. 158

Fig. 9. *Tellina* (*Angulus*) *rubescens* HANLEY. Upper San Pedro series, San Pedro. Longitude 42 mm.; natural size. 159



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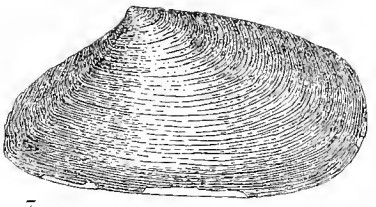

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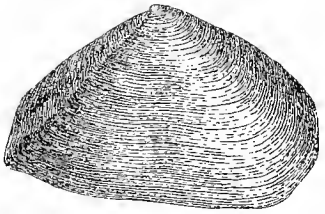

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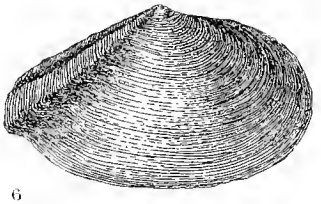

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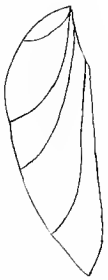

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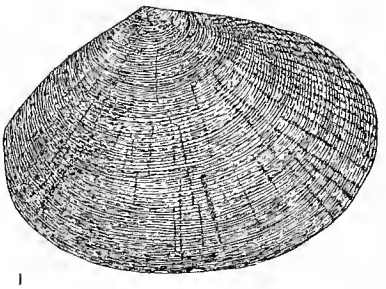

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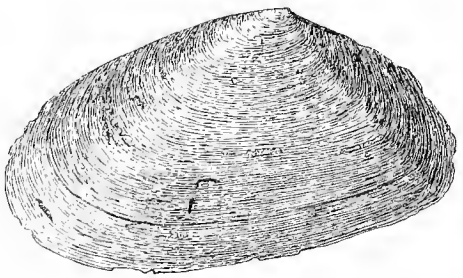

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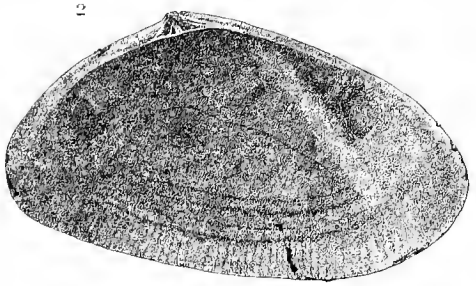

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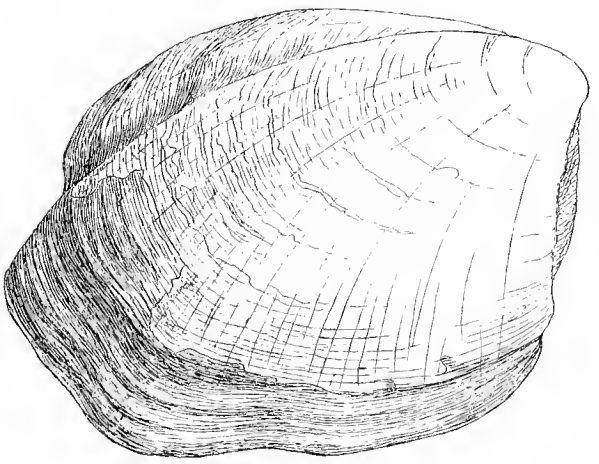

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## EXPLANATION OF PLATE XVI.

Fig. 1. *Macoma indentata* CARPENTER. Upper San Pedro series, Los Cerritos. Longitude 50 mm.; natural size. 161

Fig. 2. *Macoma calcarea* GMELIN. Lower San Pedro series, Deadman Island. Longitude 18 mm.; ×2.3. 161

Fig. 3. *Macoma nasuta* CONRAD. Upper San Pedro series, San Pedro. Large, typical specimen. Longitude 75 mm.; natural size. 163

Fig. 4. *Macoma inquinata* DESHAYES. Upper San Pedro series, San Pedro. Longitude 42 mm.; natural size. 162

Fig. 5. *Macoma secta* CONRAD. Upper San Pedro series, San Pedro. Longitude 82 mm.; natural size. 164

Fig. 6. *Macoma yoldiformis* CARPENTER. Lower San Pedro series, Deadman Island. Longitude 24 mm.; natural size. 165

Fig. 7. *Venus* (*Chione*) *gnidia* BRODERIP & SOWERBY. Upper San Pedro series, San Pedro. Exterior of right valve. Longitude 96 mm.; natural size. 147

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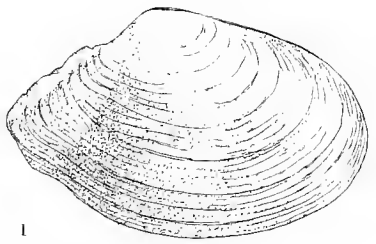

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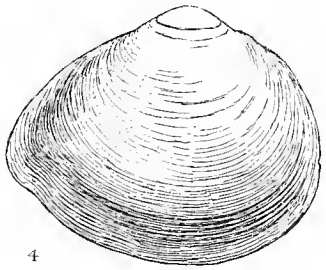

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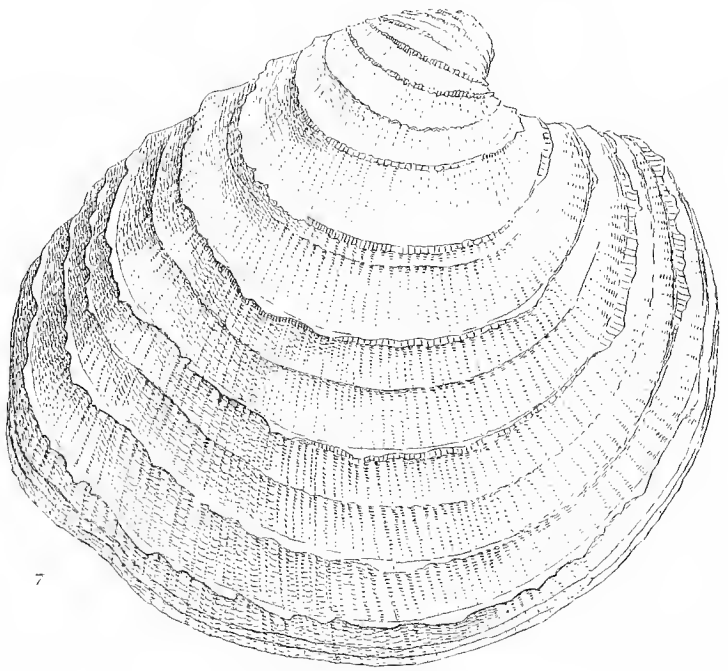

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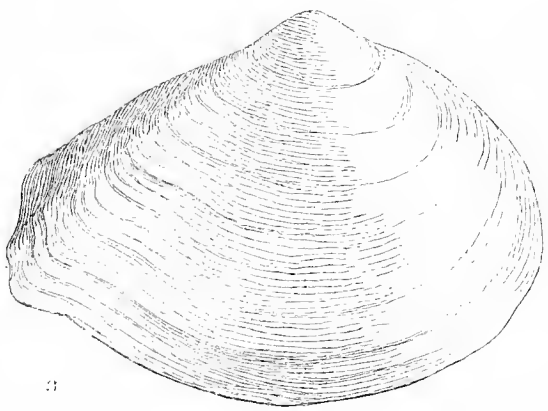

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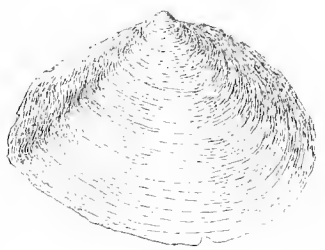

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## EXPLANATION OF PLATE XVII.

Fig. 1. *Terebratalia hemphilli* DALL. Pliocene, Santa Barbara. View of pedicle valve. Longitude 57 mm.; ×0.6. 92

Fig. 2. Same. Lateral view of both valves; ×0.6. 92

Fig. 3. Same. View of brachial valve; ×0.6. 92

Fig. 4. *Leda hamata* CARPENTER. Lower San Pedro series, Deadman Island. Longitude 9.5 mm.; ×4.5. 97

Fig. 5. *Leda taphria* DALL. Lower San Pedro series, Deadman Island. Longitude 9.6 mm.; ×4. 98

Fig. 6. *Leda minuta* var. *præcursor*, var. nov. Lower San Pedro series, Deadman Island. Type specimen. Longitude 9 mm.; ×5. 97

Fig. 7. *Leda fossa* BAIRD. Lower San Pedro series, Deadman Island. Longitude 13.5 mm.; ×3.2. 96

Fig. 8. *Mytilimeria nuttalli* CONRAD. Lower San Pedro series, Deadman Island. Altitude 17 mm.; ×1.4. 126

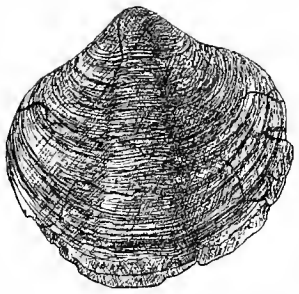
Fig. 9. *Terebratalia smithi*, sp. nov. Pliocene, Deadman Island. Type specimen. Altitude 50 mm.; natural size. 93

Fig. 10. *Verticordia novemcostata* ADAMS & REEVE. Lower San Pedro series, Deadman Island. Longitude 5 mm.; ×4.5. 126

Fig. 11. *Corbula luteola* CARPENTER. Lower San Pedro series, Deadman Island. Longitude 8 mm.; ×3. 181

Fig. 12. *Bornia retifera* DALL. Lower San Pedro series, Deadman Island. Interior view, showing hinge. Longitude 7.5 mm.; ×4. 136

Fig. 13. *Yoldia scissurata* DALL. Lower San Pedro series, Deadman Island. Longitude 12.7 mm.; ×4. 99



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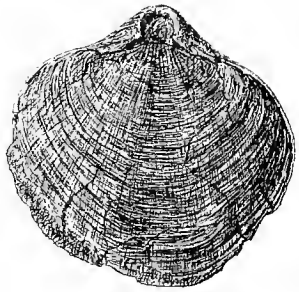

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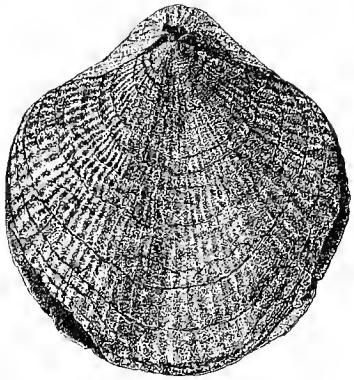

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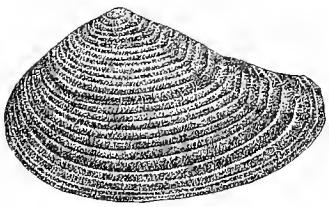

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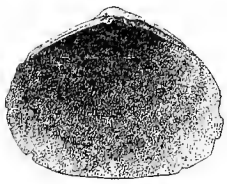

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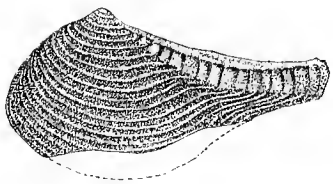

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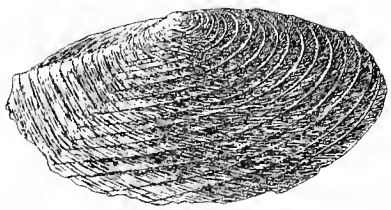

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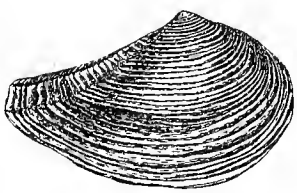

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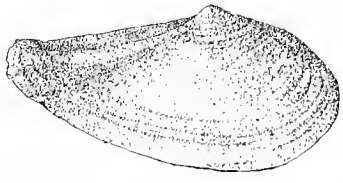

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## EXPLANATION OF PLATE XVIII.

Fig. 1. *Kellia suborbicularis* MONTAGU. Lower San Pedro series, Deadman Island. Interior view of left valve. Longitude 8 mm.; ×4.3. 137

Fig. 1*a*. Same specimen. Outline, showing convexity of valve; ×4.3. 137

Fig. 2. *Pandora* (*Kennerlia*) *bicarinata* CARPENTER. Lower San Pedro series, Deadman Island. View of imperfect left valve. Longitude 14 mm.; ×3. 123

Fig. 3. *Pandora* (*Kennerlia*) *filosa* CARPENTER. Lower San Pedro series, Deadman Island. Left valve. Longitude 15 mm.; ×3. 124

Fig. 4. *Arca labiata* SOWERBY. Upper San Pedro series, San Pedro. Longitude 28 mm.; ×1.3. 101

Fig. 5. *Diplodonta serricata* REEVE. Upper San Pedro series, San Pedro. Longitude 10.2 mm.; ×3.3. 134

Fig. 5*a*. Same. Outline, showing convexity of valve; ×3.3. 134

Fig. 6. *Nucula suprastriata* CARPENTER. Upper San Pedro series, Los Cerritos. Longitude 7 mm.; ×4.7. 96

Fig. 7. *Kellia laperousii* DESHAYES. Lower San Pedro series, Deadman Island. Interior view. Longitude 23 mm.; ×2. 137

Fig. 7*a*. Same. Outline, showing convexity of valve; ×2. 137

Fig. 8. *Diplodonta orbella* GOULD. Lower San Pedro series, Deadman Island. Longitude 9.2 mm.; ×3.3. 134

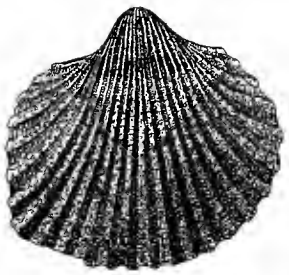
Fig. 8*a*. Same. Outline, showing convexity of valve; ×3.3. 134

Fig. 9. *Glycymeris barbarensis* CONRAD. Upper San Pedro series, San Pedro. View of interior. Longitude 25 mm.; ×1.3. 100

Fig. 10. *Glycymeris septentrionalis* MIDDENDORFF. Upper San Pedro series, San Pedro. View of interior. Longitude 22 mm.; ×1.3. 101

Fig. 11. *Neæra pectinata* CARPENTER. Lower San Pedro series, Deadman Island. Imperfect valve. Longitude 6.5 mm.; ×5.4. 181

Fig. 12. *Astarte* (*Crassinella*) *branneri* sp. nov. Upper San Pedro series, Los Cerritos. Type specimen, interior view. Longitude 11.2 mm.; ×2.7. 127



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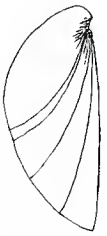

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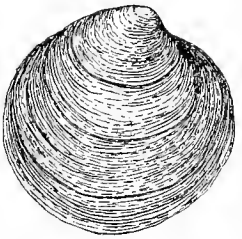

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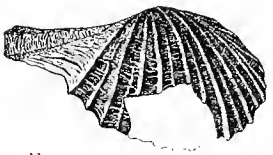

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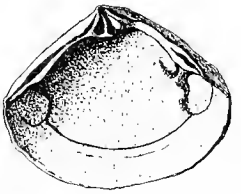

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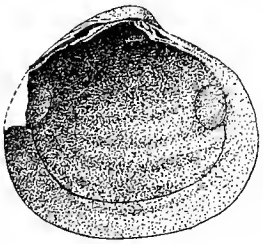

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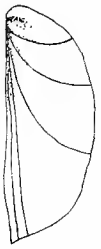

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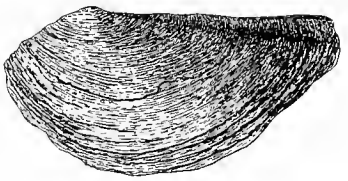

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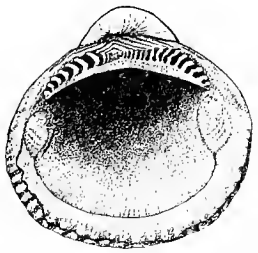

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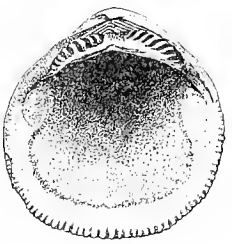

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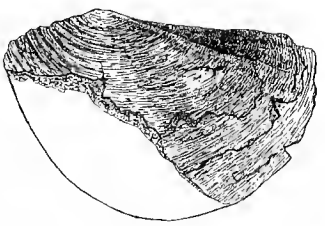

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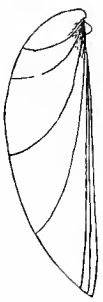

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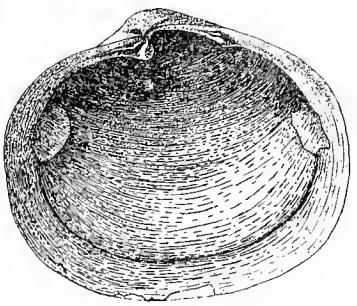

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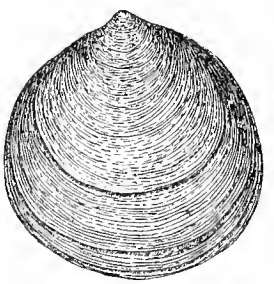

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## EXPLANATION OF PLATE XIX.

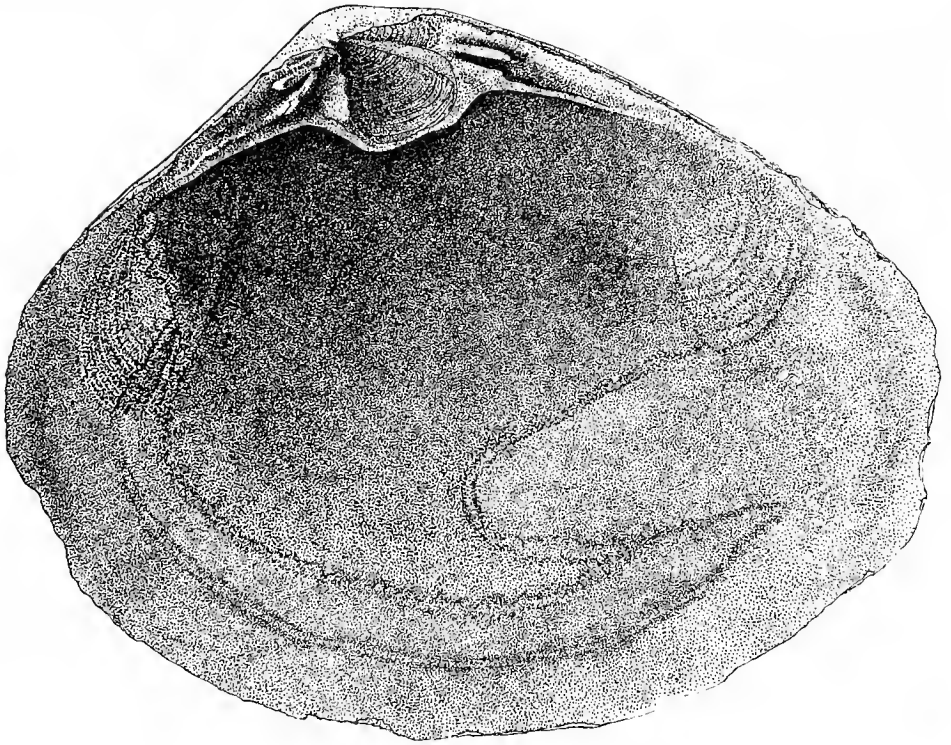
Fig. 1. *Mactra* (*Spisula*) *falcata* GOULD. Upper San Pedro series, San Pedro. Interior of left valve. Longitude 47 mm.; natural size. 176

Fig. 2. *Mactra californica* CONRAD. Upper San Pedro series, San Pedro. Interior of left valve. Longitude 39 mm.; natural size. 174

Fig. 3. *Mactra hemphilli* DALL. Upper San Pedro series, San Pedro. Interior of right valve. Longitude 124 mm; natural size. 175

Fig. 4. *Mactra exoleta* GRAY. Upper San Pedro series, San Pedro. Interior view, right valve. Longitude 57 mm.; natural size. 175

Fig. 5. *Mactra* (*Spisula*) *catilliformis* CONRAD. Upper San Pedro series, San Pedro. Interior of right valve. Longitude 125 mm.; natural size. 176



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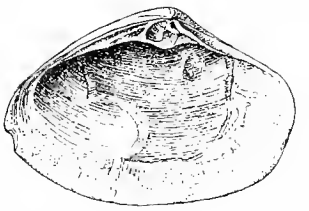

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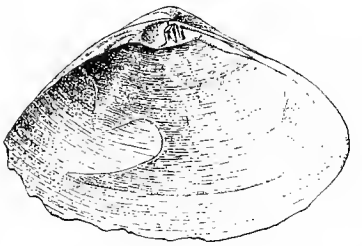

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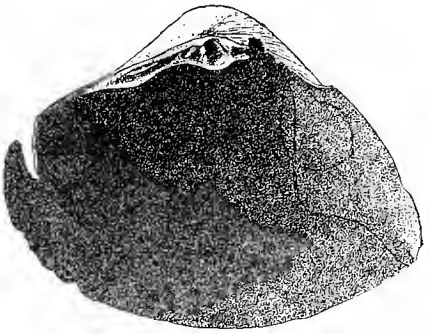

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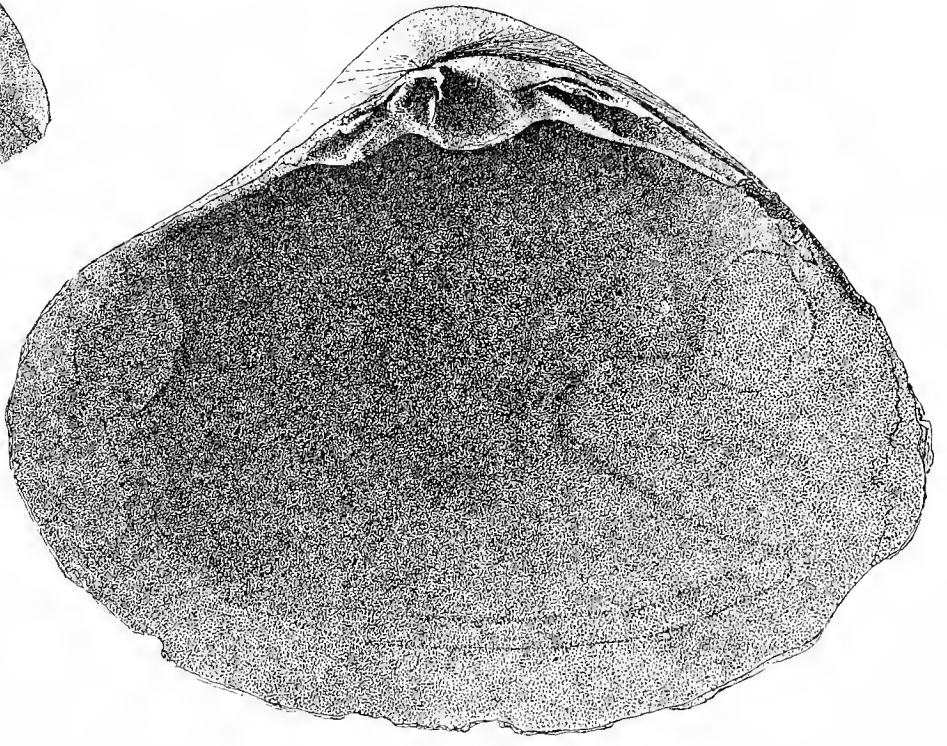


5

## EXPLANATION OF PLATE XX.

*Cardium* (*Lævicardium*) *elatum* SOWERBY. Upper San Pedro series, San Pedro. Exterior of left valve. Altitude 167 mm.; natural size. 141

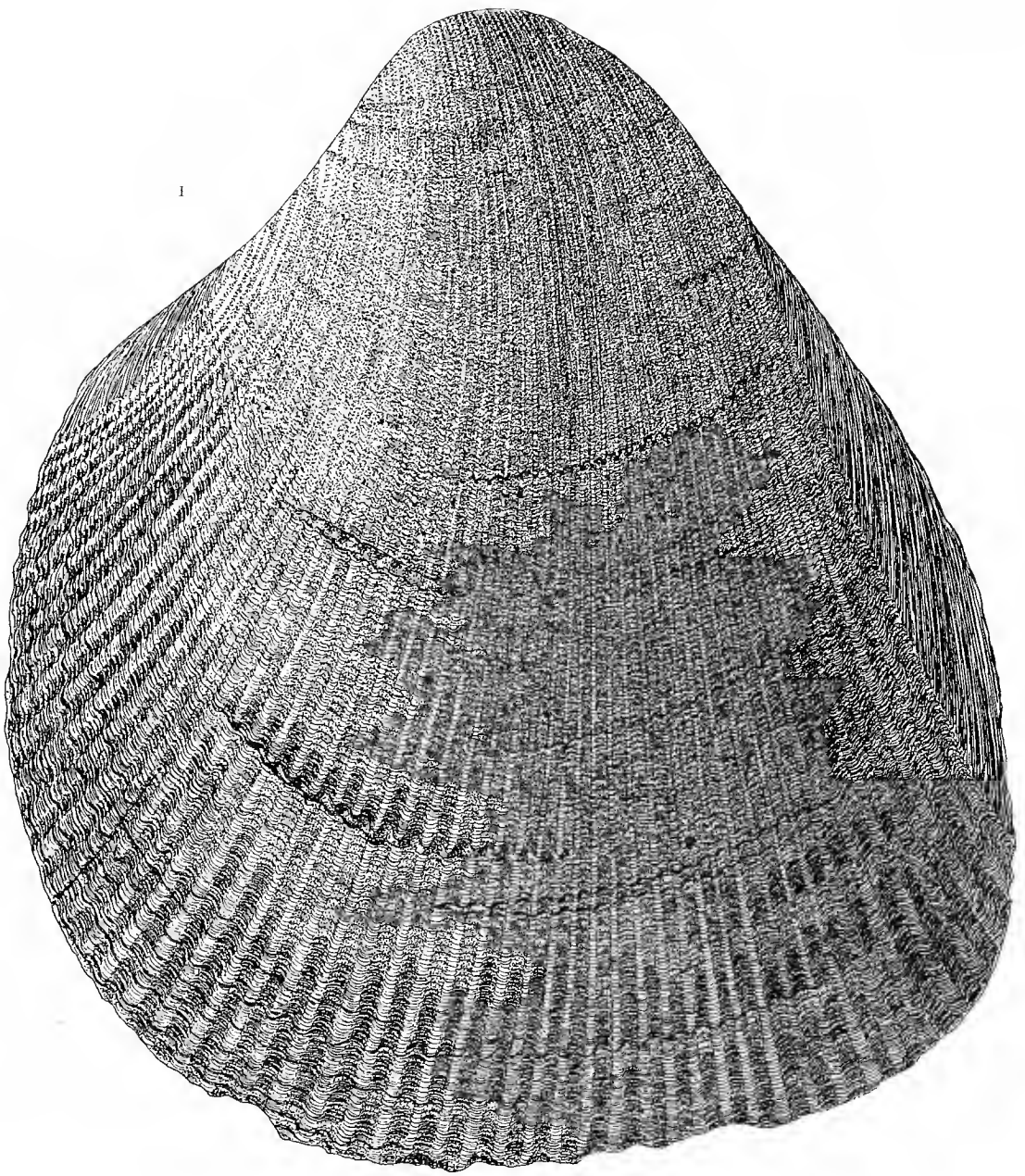
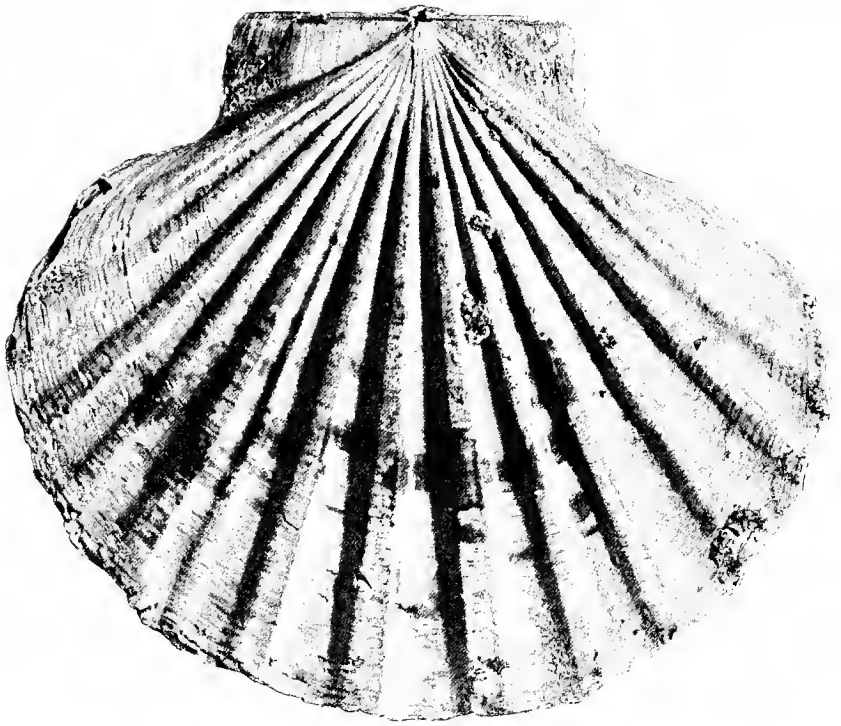


PHOTO-LITH BRITTON & REY, S.F.

## EXPLANATION OF PLATE XXI.

Fig. 1. *Pecten bellus* CONRAD. Pliocene, Santa Barbara. Left valve of Gabb's type specimen of *Janira bella* (No. 960, Collection Academy of Natural Sciences, Philadelphia). Altitude 80 mm., slightly enlarged. 103

Fig. 2. Same. Right valve. 103



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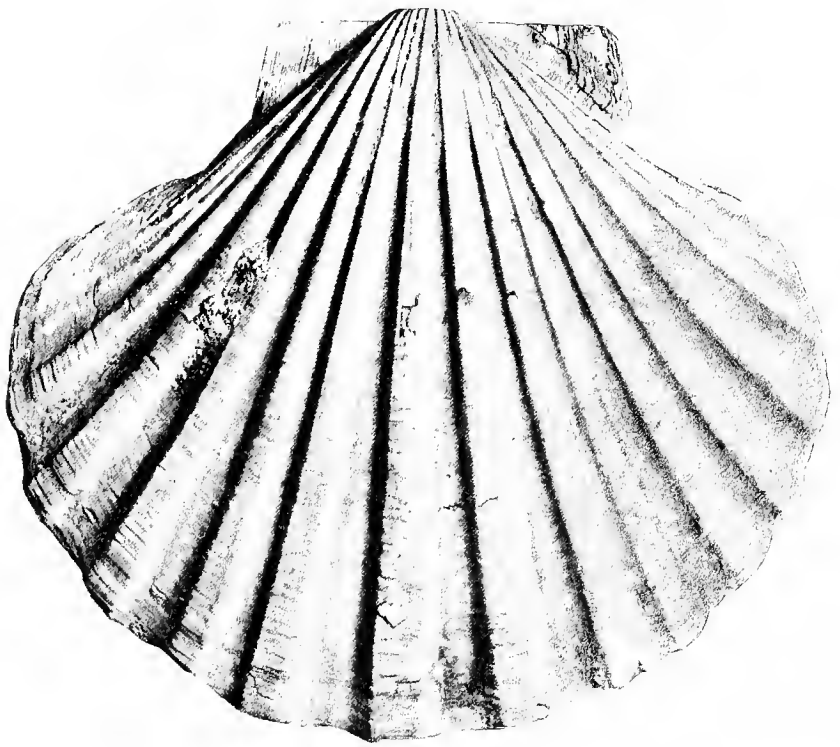
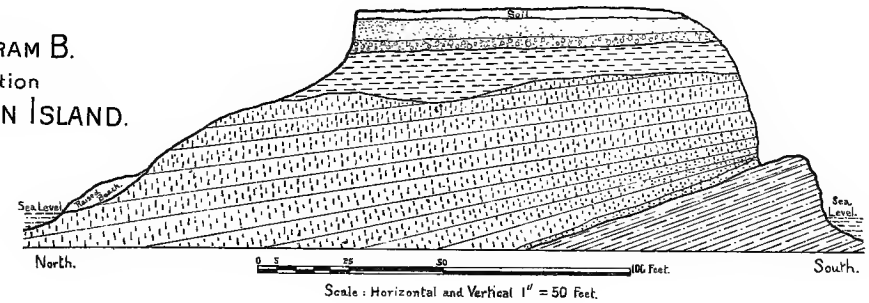


2.

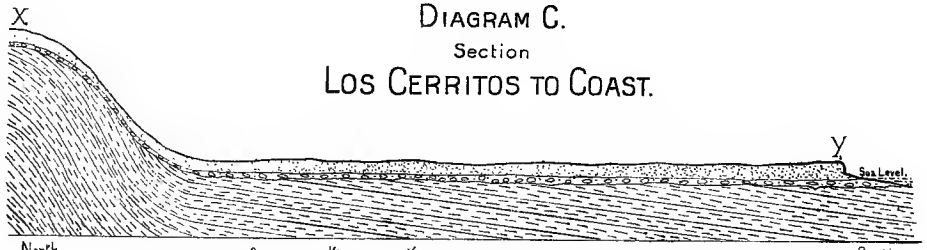
PHOTO-LITH. BRITTON & REY S.F.

## DIAGRAM B.
Section
## DEADMAN ISLAND.




Scale: Horizontal and Vertical 1" = 50 Feet.

## DIAGRAM C.
Section
## LOS CERRITOS TO COAST.




Scale: Horizontal 1"= 3/4 Mile: Vertical 1"= 400'.

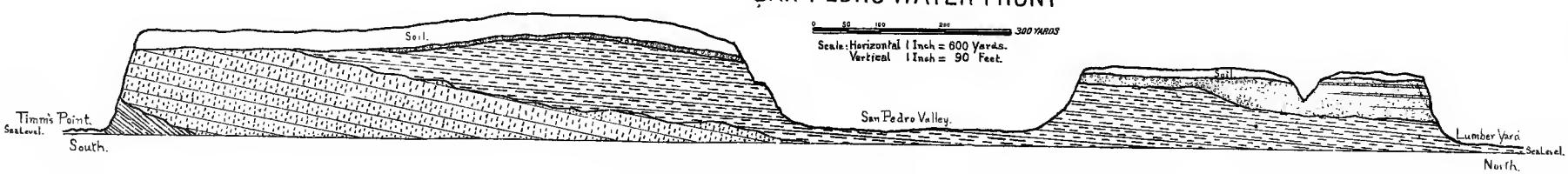
Legend.

| | | | |
|---|---|---|---|
| Upper San Pedro Series. | Pleistocene. | Sands and Gravels. |
| Lower San Pedro Series. | | White Sands. |
| San Diego Formation. | Pliocene. | Brown Sands. |
| Miocene Series. | Miocene. | Hard Shales. |

## DIAGRAM D.
Section
## SAN PEDRO WATER FRONT




Scale: Horizontal 1 Inch = 600 Yards.
Vertical 1 Inch = 90 Feet.

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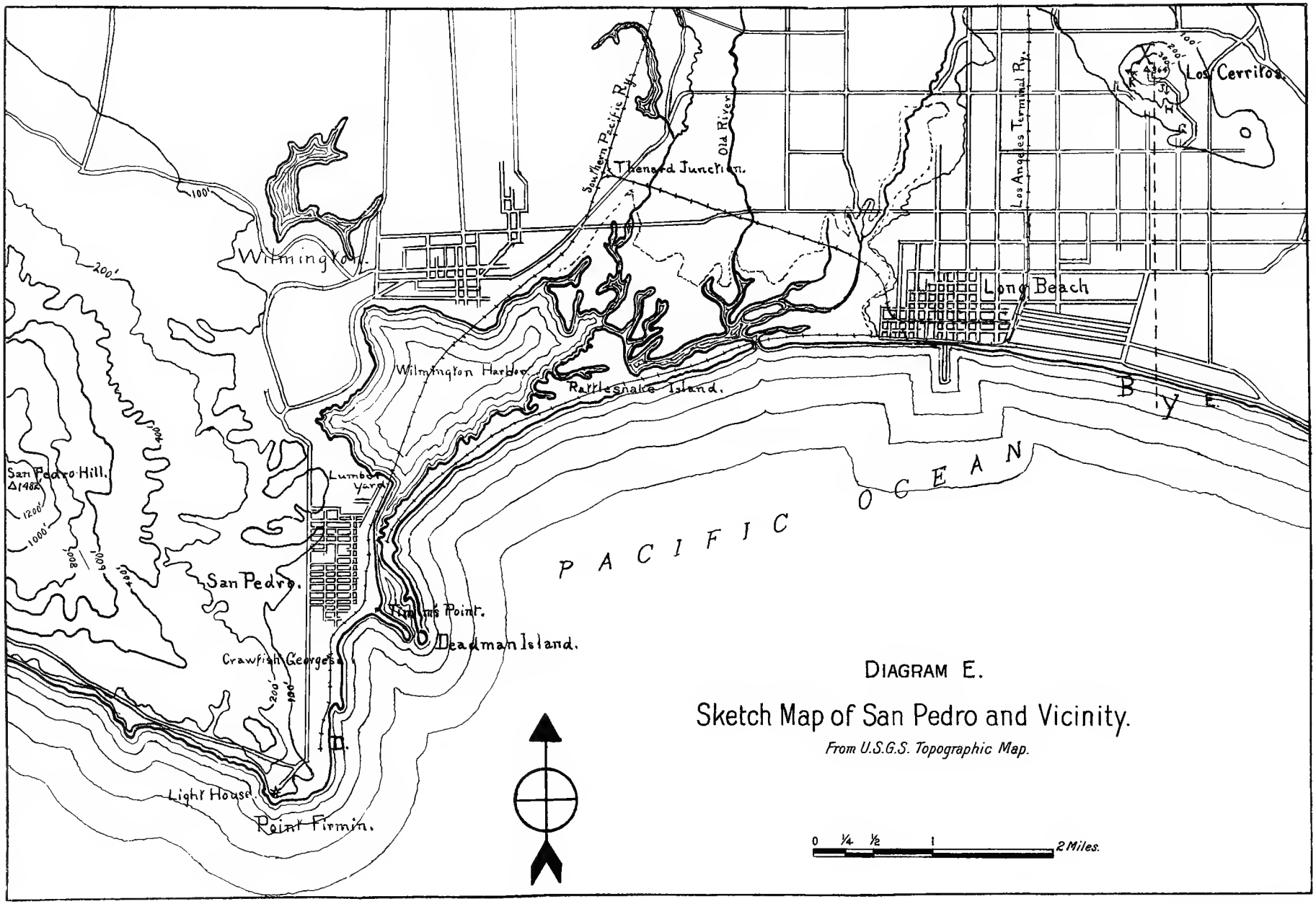


DIAGRAM E.

## Sketch Map of San Pedro and Vicinity.

*From U.S.G.S. Topographic Map.*

PHOTO-LITH. BRITTON & REY, S.F.

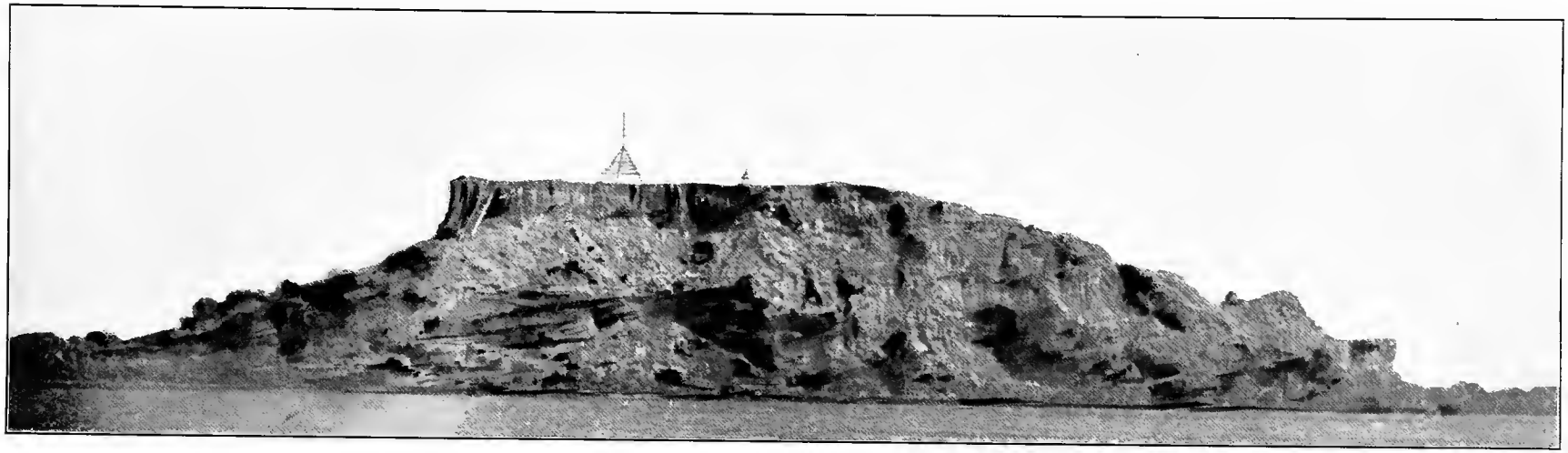

Figure a. San Pedro.—West face of Deadman Island from breakwater, showing Miocene, Pliocene and Pleistocene strata. (See Diagram B, Plate XXII, for explanation.)
Photograph by R. Arnold.

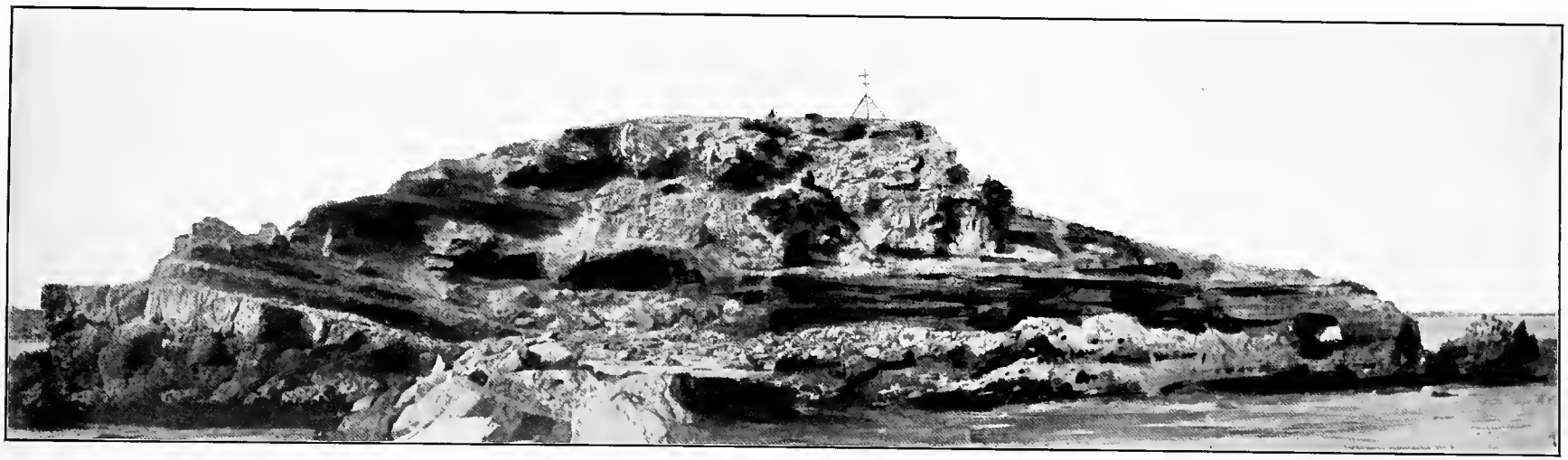

Figure b. San Pedro.—South face of Deadman Island from breakwater, showing Miocene on left, overlain by Pliocene, above which is the Pleistocene. (See Diagram B, Plate XXII, for explanation.)
Photograph by R. Arnold.

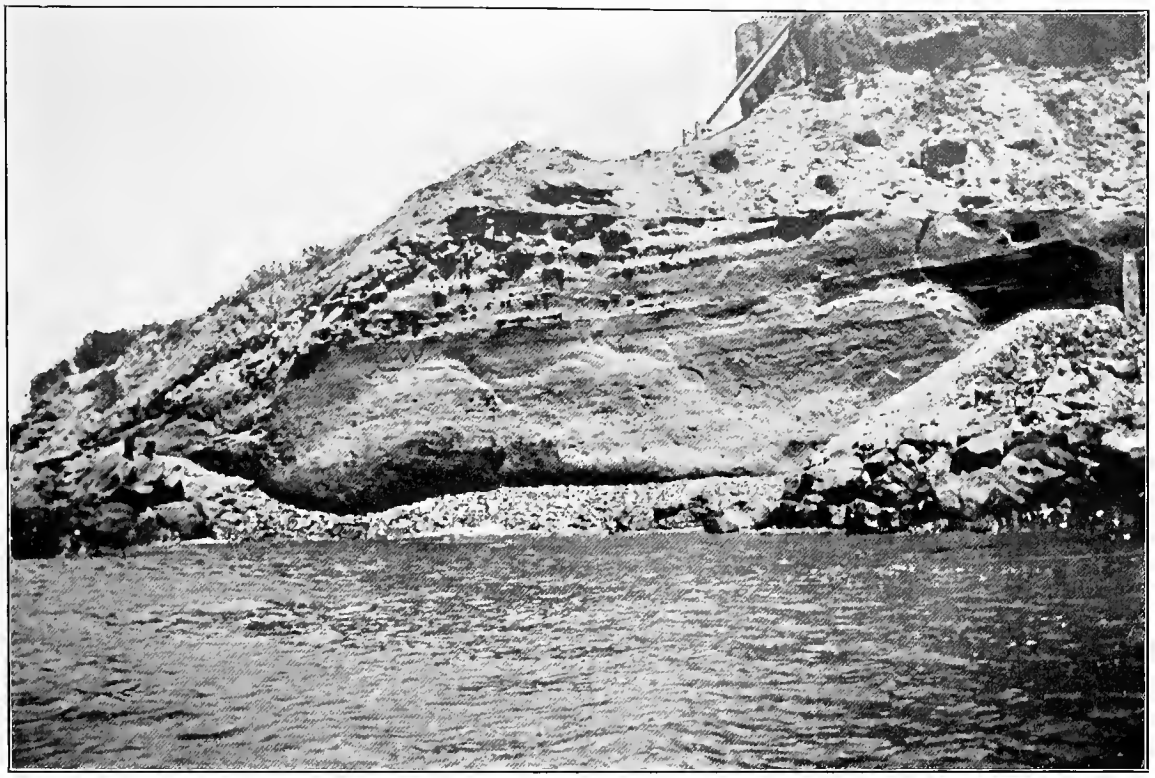

Figure a. San Pedro.—North end of Deadman Island, looking east, showing unconformity between Pliocene and lower San Pedro (Pleistocene) strata. (See Diagram B, Plate XXII, for explanation.)

Photograph by R. Arnold.

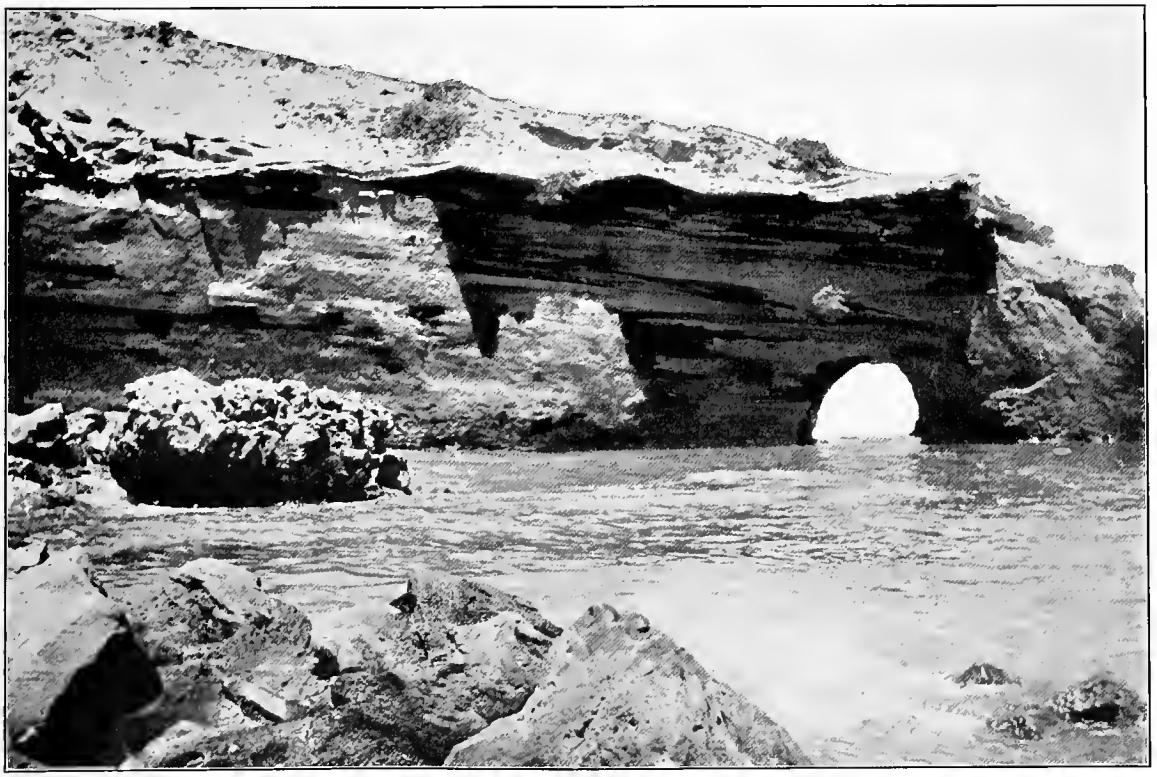

Figure b. San Pedro.—East point of Deadman Island, looking north, showing unconformity between Pliocene and lower San Pedro (Pleistocene) strata.

Photograph by R. Arnold.

Figure a. San Pedro.—San Pedro bluff, looking southwest toward the San Pedro valley, showing lower and upper San Pedro (Pleistocene) strata. (See Diagram D, Plate XXII, for explanation.)

Photograph by R. Arnold.

Figure b. San Pedro.—San Pedro bluff north of valley, looking west, showing unconformity between lower and upper San Pedro (Pleistocene) deposits. (See Diagram D, Plate XXII, for explanation.)

Photograph by Dr. H. W. Fairbanks.

Figure a. San Pedro.—North end of the San Pedro bluff, looking northwest, showing fossiliferous layers near top. Photograph by R. Arnold.

Figure b. San Pedro.—North end of the San Pedro bluff, looking southwest, showing fossiliferous layers at the bottom. Photograph by R. Arnold.

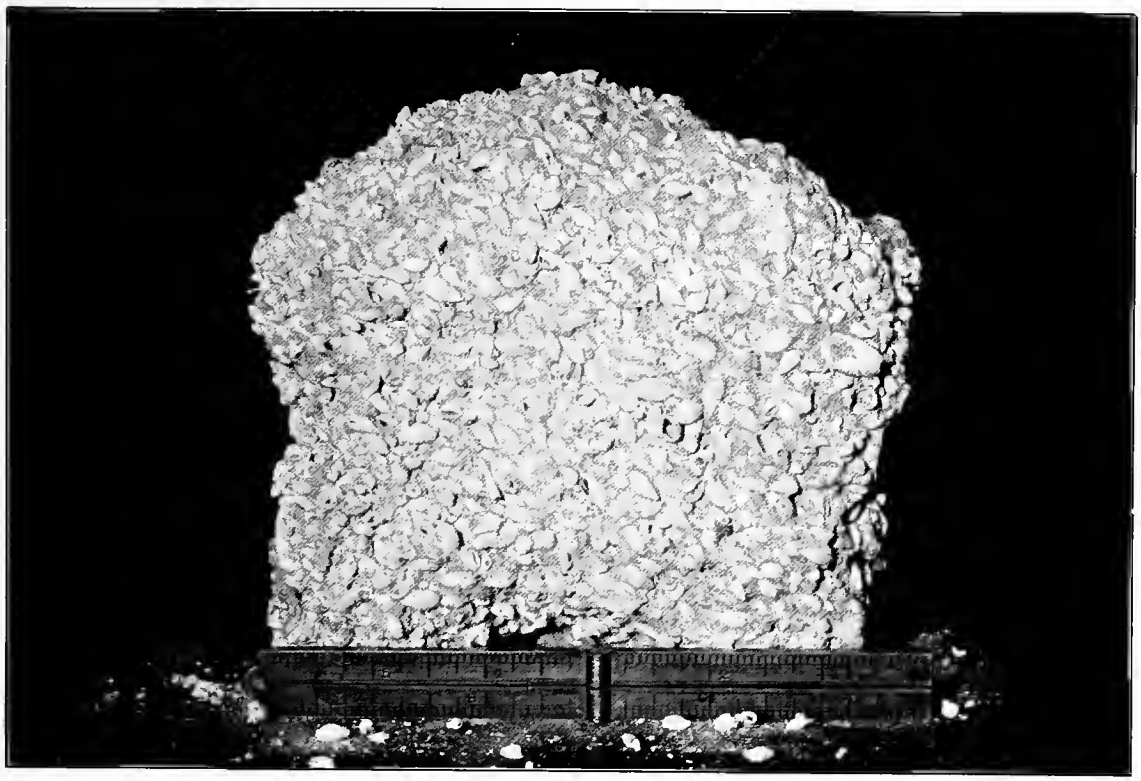

Figure a. San Pedro.—Specimen of the fossiliferous sand from the lower San Pedro deposits, San Pedro bluff, north of valley. Olivella intorta is the dominating species.

Photograph by R. Arnold.

Figure b. San Pedro.—Specimen of the fossiliferous lower San Pedro sandstone from Deadman Island.

Photograph by R. Arnold.

Figure a. Long Beach.—Bluff at Alamitos Beach, looking east, showing horizontal upper San Pedro (Pleistocene) strata. Photograph by R. Arnold.

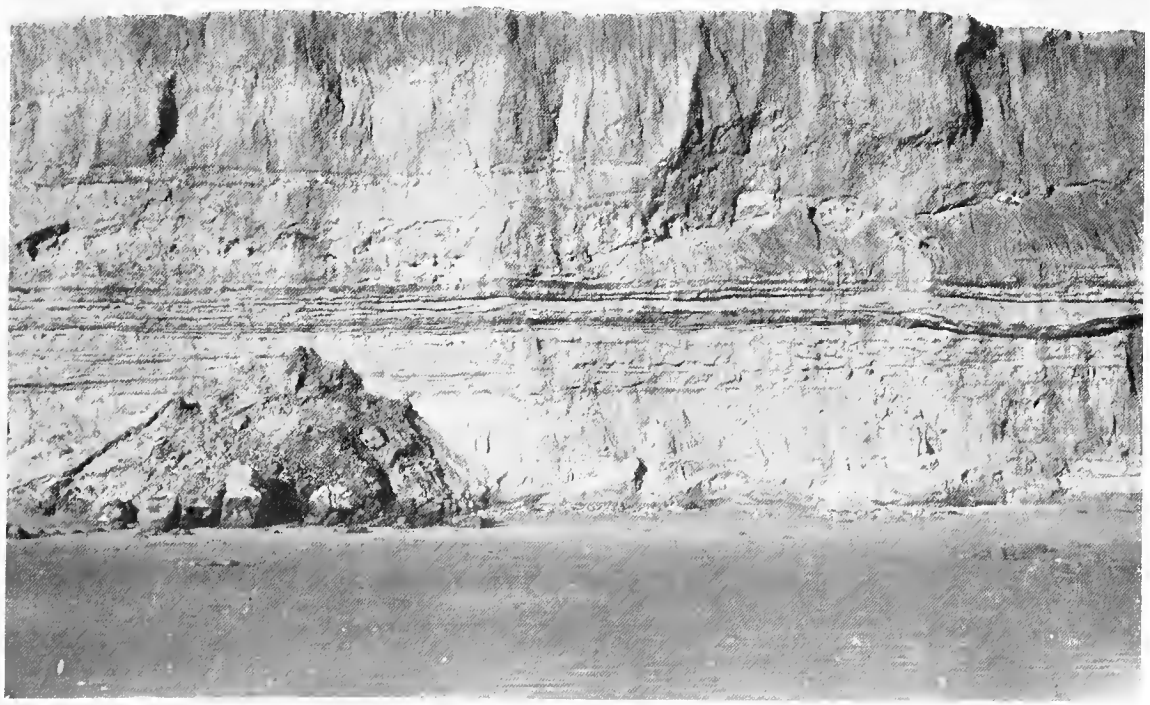

Figure b. Long Beach.—Typical section of the upper San Pedro (Pleistocene) bluff east of Long Beach. (Lowest visible layer composed of fossil shells). Photograph by R. Arnold.

Figure a. San Pedro.—South end of the lowest San Pedro terrace, looking northeast from Crawfish George's toward Timm's Point, showing the contorted Miocene shales overlain by the thin horizontal upper San Pedro (Pleistocene) layer. Photograph by R. Arnold.

Figure b. Port Harford.—Railroad cut at Fossil Point, looking south, showing Indian kitchen-midden six feet thick and full of shells overlying the Pleistocene deposit of brecciated shale.

Photograph by R. Arnold.

Figure a. Pismo.—Section of sea-cliff three miles northwest of Pismo, showing Miocene shales on right, overlain unconformably by San Pablo (Middle Neocene) sandstone on left, the whole capped by horizontal Pleistocene deposits of brecciated shale. Photograph by R. Arnold.

Figure b. Santa Barbara.—Bluff just west of the bath-house, showing alternating hard and soft layers of the lower San Pedro (Pleistocene) sandstone. Photograph by R. Arnold.

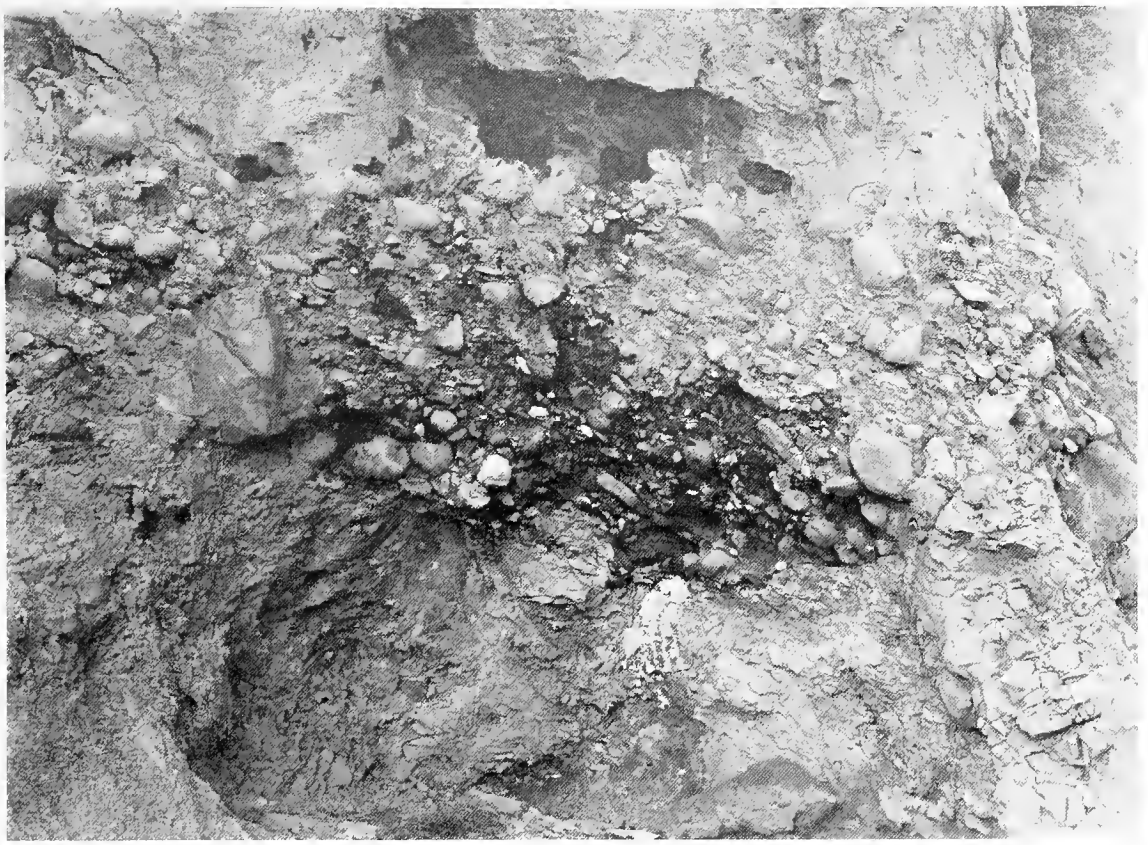

Figure a. Santa Barbara.—Portion of bluff west of Rocky Point, showing asphaltum-impregnated Pleistocene gravels resting on the Miocene shales. Photograph by R. Arnold.

Figure b. Santa Barbara.—Bluff west of Rocky Point, showing the Pleistocene sands and gravels resting on the Miocene shales. Photograph by R. Arnold.

Figure a. Ventura.—West side of the Ojai Valley, looking west from the boulevard, showing two of the three wave-cut terraces in Pleistocene sediments. Photograph by R. Arnold.

Figure b. Ventura.—Hills north of Ventura composed of Pleistocene sediments, looking northeast. The old irrigating ditch is seen about half way up the hill. Photograph by R. Arnold.

Figure a. Ventura.—Side of ravine above the Barlow ranch house, looking west, showing fossiliferous upper San Pedro (Pleistocene) beds at an elevation of over six hundred feet above sea-level, dipping at an angle of over 40°. Photograph by R. Arnold.

Figure b. San Diego.—Bluff at La Jolla capped by Pleistocene deposit of gravel and sand.
Photograph by F. L. Park.

Figure a. San Diego.—Bluff at foot of Twenty-sixth street, looking north, showing the fossiliferous upper San Pedro (Pleistocene) deposits in the lower half of the bluff. The Anomia limatula bed is at the very base of the bluff and forms the reefs at the right of the picture.

Photograph by R. Arnold.

Figure b. San Diego.—Small section of the sea-cliff at Pacific Beach, showing Pecten expansus and Opalia varicostata in the matrix of the San Diego formation (Pliocene).

Photograph by R. Arnold.

Figure a. San Diego.—Sea-cliff at Pacific Beach, looking north, showing the base of the slightly tilted sandstone of the San Diego formation (Pliocene), resting on massive gravels and conglomerates.

Photograph by R. Arnold.

Figure b. San Diego.—Sea-cliff at Pacific Beach, looking north from a point one-half mile north of Ocean Front, showing slightly tilted sandstones of the San Diego (Pliocene) formation capped by horizontal upper San Pedro (Pleistocene) gravels.

Photograph by R. Arnold.

Figure a. San Diego.—Bluff and beach at Spanish Bight, looking north, showing the very fossiliferous layer at the base of the bluff which also forms the beach at this point.

Photograph by R. Arnold.

Figure b. San Diego.—A closer view of the beach at Spanish Bight. Most of the shells seen in this picture are in place in the hard Pleistocene sand layer which forms the beach at this point.

Photograph by R. Arnold.

# INDEX TO VOLUME III.

New generic, specific and subspecific names in **heavy-faced** type; synonyms in *italics*.


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